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CROSS-FERTILISATION IN SOCIOLOGY.—I.

By J. COLLIER.

THE assertion was perhaps first made by Niebuhr, repeated by Whately, and supposed to be very damaging to the alleged evolution of the higher races of man from the lower, that there is no instance on record of a savage people raising itself unaided from barbarism to civilisation. Might not the criticism be generalised? Can it not be affirmed that there is no recorded example of any people rising considerably in the scale of culture otherwise than by receiving stimulation, amicable or hostile, from other peoples? For it may happen in two ways. A man is "made by his enemies," like Mr. Chamberlain, and nations have been brought to the point of self-conscious individuality, as happened to England and France, to France and Germany, by mutual animosity. French and English historians agree that the latter stages of the French Revolution were initiated by the hostility of coalised Europe. But wrath and hatred are not at the base of collective any more than of individual life; the chief social regenerator is love, and in its primary form. The floral world has been finely shown to owe its beauty and magnificence to cross-fertilisation; the animal world might likewise be shown to be indebted for its vigour and variety to intercrossing. So might it be proved that most great advances in civilisation have been originated by the blending of two stocks, the immigration of individuals from one society to another, the temporary migration of individuals to other societies, the transmission of germs from one society to another by various agencies, or by the reaction of one portion of a community on another, or of one form of social life on another. These are, all of them, robust or "degraded" modes of intercrossing or cross-fertilisation.

CROSS-BREEDING IN PHILOSOPHY.

A rapid sketch of a single line of development will reveal something of the part that this great natural agency has played in history. All the leading philosophies have been born of the contact of alien ideas with native systems. Platonism was begotten by the soaring speculations of the Italian Eleates on the stubborn realism of Socrates. Aristotle was formed by opposition to his master and by a species of intercrossing; in him metaphysic was, as it has all along been, fertilised by contemporary science. Pantheistic Stoicism was the offspring of Asiatic thought on Greek thought; Deistic Epicureanism of atomistic science on the same basis. Greek Eclecticism consisted of a medley of systems intermingled by Syrian, Phœnician, Greek, and Roman thinkers. Neo-Platonism blended Aristotelianism and Platonism with an Oriental admixture. Mediæval Scholasticism was the outcome of Aristotelianism applied to Christian theology. The scientific discoveries of the seventeenth century bred an original philosophy equally on the sympathetic Scholasticism of Descartes and on Hobbes's antagonism to Scholasticism. Cartesianism generated Spinozism on the traditions of the Cabbala. Spinozism introduced the new element of immanence into the philosophy of Europe. Kantism was begotten by the scepticism of Hume on the metaphysic of Wolf and Tetens. The cloudy transcendentalism of Schelling was the phantom produced by the union of Oken's pseudo-science with Kantism. The old French philosophy took on a new character in Royer-Collard under the influence of Reid. Victor Cousin owed his originality to an early infusion of German doctrines. Hamilton repaid Kant's debt to Hume by affiliating himself on Kant, with Reid for matrix. Ferrier reared a bright castle-in-the-air under the inspiration of Berkeley. And Mr. Spencer acknowledges that a formula of von Baer was the starting-point of his evolutionary (and revolutionary) career.

These are the blue gentians and the gorgeous water-lilies of the speculative reason, and, like their vegetal analogues, they owe their brilliancy to the mingling of diverse stocks. What a self-fertilising philosophy may come to we see in later lifeless Scholasticism. Wooden Dutch philosophy after Spinoza, the sounding inanities of Italian philosophy between Vico and Vera, the dull platitudes of Scottish philosophy from Dugald Stewart to McCosh, later Spanish philosophy, and the orthodox official philosophy of all countries. These are the useful grasses and useless sedges of thought, whose small, pale, etiolated blossoms do not minister delight or attract the wayfarer.

MASS-FERTILISATION.

All through Nature the male seeks the female. The masculine peoples—the Greeks for a time, the Romans pre-eminently, the Spaniards of the sixteenth century, the English of the last three centuries, and now the Russians—have spread themselves over the world in search of

feminine peoples to be conquered or civilised. The effect they produce is proportionate (1) to the prepotency of the aggressive element, and (2) to the amount of it. The Macedonian highlanders, reinforced by Greeks from the islands and the two mainlands, who Hellenized Asia and Egypt under Alexander and his successors, cannot have been very numerous, but their propagandist energy and intellectual superiority raised their prepotency to the highest point ever attained. Accordingly, they diffused Greek culture over a large part of the East, developed Greek philosophy and science, and prepared a theatre for the reception of Christianity. Cosmopolitan Alexandria, in particular, was at once a menstruum of nationalities, and the scene of the fusion of Oriental and Occidental thought.

It is estimated by M. Jullien that the colonists settled in Gaul by Julius Cæsar and Augustus did not exceed thirty thousand. Add merchants, artizans, functionaries and slaves, and the total may still be inconsiderable. Yet with this limited material, the world-moulding people modelled Provence in its own image, and from this base it Romanised Northern Gaul, Western Germany, and Southern Britain. The Roman talent for government made the Romans as prepotent morally as the Greeks were intellectually.

In northern Gaul the Franks were more prepotent than their Visigothic kin in the south, and probably more numerous than the Romans there. They yet created no new ethnical type, but only reinforced the fair dolichocephalic element. They strengthened the characters of energy, firmness, and seriousness in the Gaulish temperament. They did not produce the feudal *régime*, but they contributed the fructifying pollen which developed it out of existing usages, thus made it inevitable, and added to it certain features that were peculiar to themselves. Mediæval chivalry was the offspring of the marriage of the German with the Gaulish minds. The key to French history lies in the perception of this periodic cross-fertilisation. We observe it again in the abortive Reformation of the sixteenth century, in the critical movement of the eighteenth century, in French philosophy under Louis Philippe, in the French literature of the sixties, and French science of the nineties.

The numbers of the Saracen invaders of Spain are stated at twenty-two thousand; these were doubtless largely increased by later immigration, but seven centuries afterwards they did not exceed two hundred thousand. Yet their influence on Visigothic Spain was deep and has been lasting. By constant intermarriages they created a new ethnical type, of mixed Arab and Spanish blood. Is the ferocity of the Spanish character, as plainly shown in its saints as in its hidalgos, in its religion as in its conquests and its sports, derived from the foundation of savagery in the Semitic nature? They modified the physical environment by erecting public buildings and constructing a system of irrigation that are still in use. They established the culture of silk and sugar. They transmitted the manufacture of paper and of gunpowder, and the binding of books. They changed the face of pharmacy and medicine. They diffused over Europe the Arabic numerals, algebra and the higher mathematics. Heeren asserts that they made no important discovery, but others allege that they originated the germs of many later discoveries. They deeply affected the vocabulary, the literary forms, and the spirit of Castilian literature. Their influence on philosophy can be definitely stated. They translated the works of Aristotle from the Syriac versions, not from the Greek. The Arabic versions were translated into Hebrew by the Jews, whose translations were translated into Latin. Aristotle four times decanted was the only Aristotle the early Schoolmen knew. Aristotle was commented on by Arabian Averroes; Averroes was commented on by Jewish Maimonides; and from these blended sources Greek-Arabic-Jewish speculations flowed into mediæval Europe by influencing Alexander of Hales, Bonaventura, and Albertus Magnus, the earliest Schoolmen. In all these ways the Arabians communicated fresh vigour to the European intellect.

The little band of Normans who conquered Calabria and Apulia consisted of no more than twelve hundred horse and foot, though in twenty years it swelled to the legendary total of sixty thousand. We should expect their prepotency to have been more military than intellectual or commercial; yet they set up the earliest medical school in Europe, and founded the city that first distributed the products and manufactures of the East. To Sicily the same conquering race transported from Athens, Corinth and Thebes, a captive multitude of silk weavers and artizans, who planted new industries in Italy. To England it brought the seeds of new institutions, new arts, new philosophies and theologies. The history of our own country strikingly illustrates the Darwinian principle that a social organism crossed, though at distant intervals, with kindred varieties, gains vigour and fecundity.

GROUP-FERTILISATION.

Countries are fertilised by groups as well as by masses. In the third century Germany received the first seeds of Christianity at the hands of Roman refugees from persecution; and at the same time a multitude of Roman provincials, captives of the Goths, diffused the same religion in Dacia among their masters, whose apostle, Ulphilos, invented the Gothic alphabet. In the sixth century the bigotry of Justinian drove thousands of his industrious Nestorian subjects from all provinces of the Eastern Empire, whence they carried into Persia the arts alike of peace and war. About the middle of the eighth century Constantine Copronymus transplanted the sect of Paulicians from the banks of the Euphrates to Constantinople and Thrace, where they introduced and diffused the germs of Protestantism. They were strengthened by a second and larger contingent, transported two hundred years later from the Chalybian hills to the valleys of Mount Hæmus. They spread from Bulgaria, Croatia and Dalmatia, into the Greek provinces of Italy and Sicily, whence they silently propagated their opinions as far as Rome and Milan. In the south of France they were known as the Albigeois, whose bleeding remnants bore their faith into Northern France, England, Bohemia, and Germany. An unbroken chain thus links the second founder of Christianity to Wickliffe and Jerome, Calvin and Luther. The exiled French Huguenots conveyed to Prussia the secrets of several lucrative industries, and (according to Laveleye) communicated to the Berlin mind the vivacity and precision that have aided it in gaining an ascendancy over the vague and dreamy spirit of Germany. They brought to England sugar refining, and introduced improvements in the paper manufacture But the best gifts are men. The Huguenots took to Germany the ancestors of Savigny, who founded a new school of law and a new method—the historical method, and Beausobre, who initiated a new species of history—the history of doctrines. To England they brought the "dissidence of Dissent, and the Protestantism of the Protestant religion" in an ancestor of Edward Miall; in an ancestor of James Martineau, that "purer and more perfect theism" to which Gladstone believed that religion would one day be reduced; while his sister, Harriet, was the masculine expositor of an

enlightened secularism. These were the developments of Protestant germs. In John Henry Newman the sturdy Huguenot stock may not seem to have been prepotent; but the priest who denounced the "insolent and aggressive faction" that forced on an Ecumenical Council the definition of the dogma of Papal infallibility, like the cardinal who kept the *Decline and Fall* constantly on his desk, must have remained a Protestant at heart.

ST. SOPHIA, CONSTANTINOPLE.

By E. M. ANTONIADI, F.R.A.S.

Illustrated from original drawings by the Author.

I.

INTRODUCTORY.

THERE is much to attract the archæologist in the city of Constantine. Gigantic ruins of land and sea walls; towers picturesquely invaded by luxuriant vegetation, and cracked by frequent earthquakes in a geologically wavering soil; imposing remains of once garish palaces; magnificent churches, often preserved intact; monumental aqueducts; vast cisterns; and inextricable subterranean labyrinths, are as many fascinating subjects of study to the inquisitive mind.

During his long stay in Constantinople, the writer took some interest in archæology, but only as a recreation from business and astronomical observations. It was at once felt, however, that the subject of Byzantine antiquities, as a whole, was too vast to be seriously undertaken; and that the justification for any claims to originality in the final results involved a strict specialisation of the enquiry in a limited domain of mediæval Greek architecture.

St. Sophia, the splendid cathedral, and now the great mosque of Constantinople, presented a particular attraction to the writer through the mystery veiling its former condition, and, especially, its inner division as a Christian church. From 1889 to 1893, he visited that celebrated shrine hundreds of times, and took accurate plans, sections and elevations of it, as well as a very large number of drawings of its appearance. These data have been further completed and checked by photography; so that the equipment for understanding the text of the Greek historians in the light of the present building was as satisfactory as could reasonably be expected.

Much assistance was received at the time from the late Canon Curtis, of the Crimean Memorial Church, Constantinople; while the disinterested willingness of the Turkish guides of the mosque in giving honest and valuable information was most welcome and gratifying.

HISTORICAL NOTICES.

The foundation of a church dedicated to the Holy Wisdom, or to Christ himself, is attributed to Constantine the Great. It appears that the structure was begun towards 326 A.D., and that its dedication did not take place before 360, in the reign of Constantius. The form of the first church was that of the basilica type, probably with three naves covered with barrel vaults, the central vault resting on two rows of columns. Burned partly by the partisans of St. John Chrysostom, who was banished from the city in 404, and again restored by Theodosius the Younger in 415, Constantine's church was at last totally destroyed by fire in the Nika riot of 532.

The quell of the rebellion raised Justinian to the acme of power. His ambition was to reconstruct the church in such splendour as to transcend anything ever achieved before; and the unrivalled genius of his architect, Anthemius of Tralles, enabled the emperor to produce a building which, in originality of design, audacity of structure, and gorgeousness of decoration, has never since been equalled, or even approached. It was only thirty-nine days after the fire that Justinian undertook the reconstruction, and he pushed the work with such relentless activity, that the present building was completed and opened in the incredibly short space of not even six years; the dedication actually taking place on Christmas Day, 537.

The 1365 years separating us from the dedication saw vast changes in the appearance of the church. In the first place, the original dome, which was twenty feet flatter

FIG. 1.—St. Sophia at sunset, with light streaming through the Dome. (Appearance of the Mosque towards 1455, at the completion of the Minaret erected by Mohammed II.)

than the present one, fell in 558 through the effects of repeated earthquakes, and it was thought safer, in its reconstruction, to check somehow the thrust by raising the curve to a greater height. The second dedication under Justinian took place once more on Christmas Day, 563, seven years before the birth of Mohammed.

An adumbration of the subsequent history of St. Sophia may be given as follows:—

A.D. 620±. At the critical moment of the war between Heraclius and Chosroes the Church comes nobly forward and saves the State, by coining many of the treasures in its possession.

628. Heraclius lifts in triumph the wood of the True Cross before the altar of St. Sophia.

725. Leo the Isaurian issues his first edict against image worship.

741. Great Earthquake of Constantinople.

842. End of the Iconoclastic controversy; triumph of Orthodoxy.

865. Erection of a belfry near the west front of the church.

869. Earthquakes; the vaulting cracks in several places.

869–870. Eighth Œcumenical Synod, held in south aisle of first floor level of St. Sophia.

875±. Basil the Macedonian, consolidates the great arch to the west by an additional thickness.

975. A strong earthquake shock causes the western arch of St. Sophia to totter, and to drag the dome in its fall.

981. Basil II. restores the fallen parts.

987. The ambassadors of Wladimir are so dazzled by the grandeur of the divine service in St. Sophia that they

decide the conversion of the Russian nation to the Orthodox Greek Church.

1054. The envoys of Pope Leo IX. excommunicate the Eastern Church on the great altar of St. Sophia.

1204. Capture of Constantinople by the Crusaders. Wanton profanation of the sanctuary by the soldiery. Baldwin, of Flanders, is crowned first Latin Emperor of Constantinople in St. Sophia, which is converted into a Roman Catholic church. The *Te Deum* resounds in the dome for fifty-seven years.

1261. Constantinople is reconquered by the Greeks and St. Sophia restored to the Orthodox faith.

1317. Andronicus Paleologos, the Elder, erects the huge buttress masses disfiguring the outside.

1346. Earthquakes. Collapse of the great eastern arch and of all that part of the dome resting on it.

1360±. Restoration of the vault by John V. Paleologos.

1452. A *Te Deum* is again sung in St. Sophia, by order of the last Constantine. But this alienates the sympathies of the people, who, from that day, avoid the church as a Jewish synagogue or a heathen temple.

H.I.M. Sultan Abdul Hamid II., after the earthquake of 1894, was to appoint a commission of architects in order to study the damage, and to at once order a general repair. It is only fair, therefore, to acknowledge the great debt of gratitude we owe to the Sultans of Turkey for having preserved to the archæologist, practically intact, the grandest architectural conception the world has seen.

DESCRIPTION OF ST. SOPHIA.

The following description is a very condensed *précis* of some of the writer's conclusions regarding the former condition of St. Sophia. The illustrations are, of course, invariably original, and rest on data obtained either in sight of, or within the mosque. For the artistic effects of Figs. 1 and 2, the writer is indebted to his friend, Mr. Shirley Fox, R.B.A., whose valuable suggestions have been most welcome.

The Orientation.—This is $33\frac{2}{3}°$ south of east.* Labarte thought† this direction was given in order to render the new edifice parallel to the already existing structures of

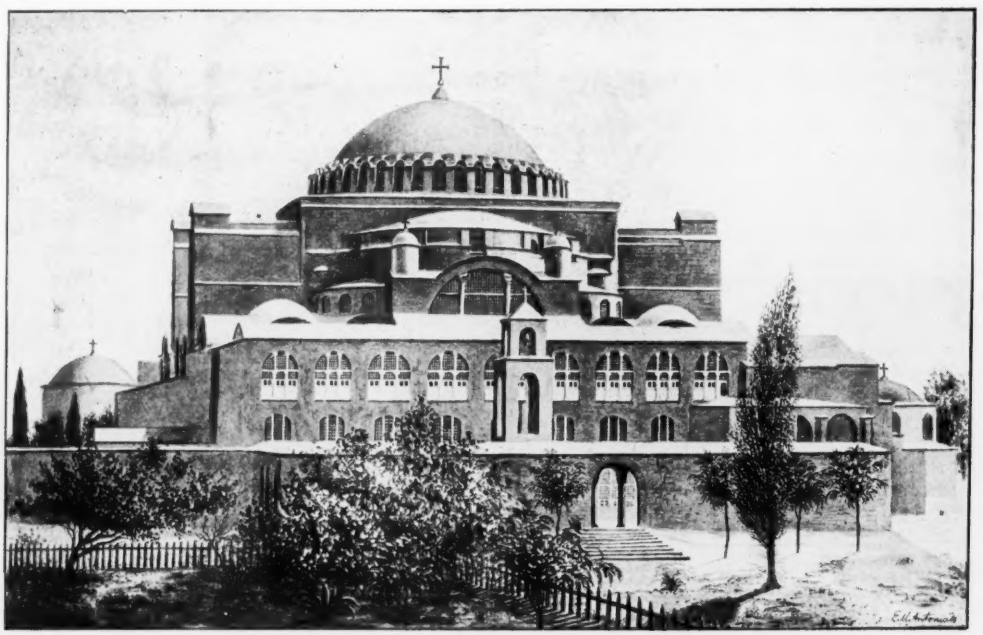

FIG. 2.—The West Front of St. Sophia, towards 870 A.D.

1453. Fall of Constantinople. Mohammed II. respects St. Sophia, which he solemnly dedicates to Islam.

A few words regarding the treatment of St. Sophia by the Turks would form a fitting conclusion to this brief historical sketch. Contrary to what is generally believed, the building did not suffer much from its new masters. The damage reduces itself to the partial scratching of the arms of some crosses in bas-relief and to the whitewash cover of the majority of the mosaics. Many mosaics have been removed as a measure of precaution, through the cracking and precariousness of the mortar in which they were fixed. This toleration for images whose representation is forbidden by the faith was attended with a pious zeal towards the preservation of the building. In 1573, Sultan Selim II. repaired the eastern arch; in 1847-1849, Sultan Abdul Mesjid spent nearly a quarter of a million sterling for a general restoration, while the first care of his son the Imperial Palace of Constantinople. The writer takes

* During his stay in Constantinople last summer, the writer found that the axis of St. Sophia, as determined by him from Kadikoy, formed an angle of 127° with the magnetic north. Messrs. Crommelin and Nash, of the Royal Observatory, Greenwich, were kind enough to give him the value, 3° 20′ West, of the declination of Constantinople for 1902. This value has been computed from a German magnetic map of the earth for 1885 and cannot be trusted to the minute. We thus have for the orientation—

$$127° - (90° + 3° 20') = 33° 40'.$$

† *Le Palais Impérial de Constantinople et ses Abords*, p. 18. Labarte commits a grave error in affirming that "it is very important to state that the major axis of the Hippodrome and the major axis of St. Sophia produced, form a right angle at their intersection." This angle actually has a value of 105°, and it is impossible to see how it could ever have had another value. Labarte's work is eminently misleading; but is it not hard to accurately describe from the rooms of a western library, a building 1400 miles off, and of which every trace has long since disappeared?

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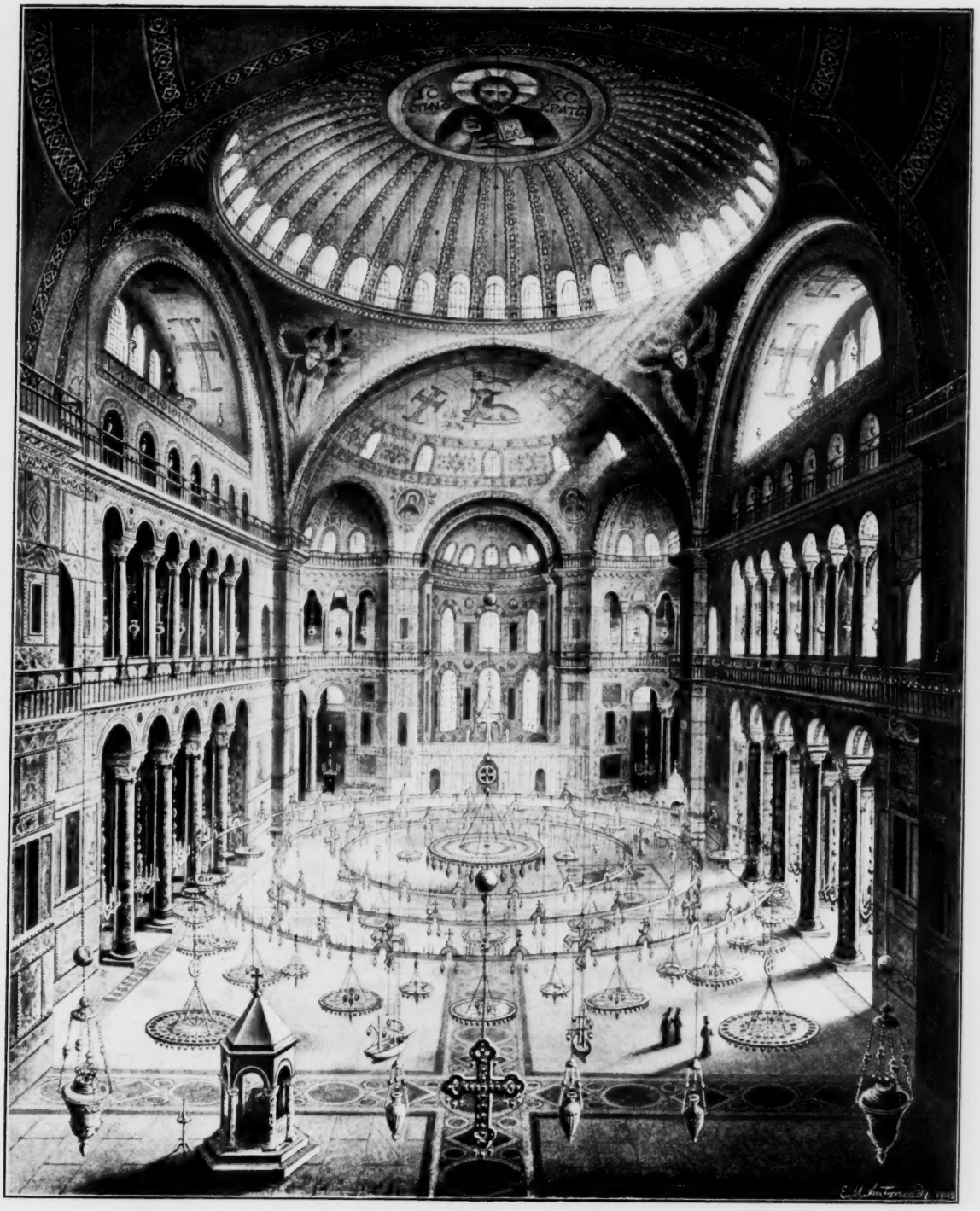

THE CHURCH OF THE IMMORTAL WISDOM.

Panoramic View of the Interior from the Stall of the Empress in the West Gallery. Epoch 538 A.D.

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this to be a very superficial view of the question, as it is hardly likely that the orientation of such a shrine could have ever been subordinated to that of some disjointed pavilions. In their excellent work, published in 1894, Messrs. Lethaby and Swainson show a much clearer grasp of the problem. "The axis of the church," they say, "seems to point somewhere between 30° and 35° south of east, where there is a considerable sea prospect and a low horizon. This direction, either by accident or intention, must agree very closely with sunrise at the winter solstice." They further call attention to the fact that "Justinian's church was opened at Christmas."* These pregnant remarks lead to a solution of the difficulty. But for this it is necessary to bear in mind:—

(*a*) That Procopius lays stress on the fact that "the face of the church was directed towards the rising sun, in order to have the sacred mysteries performed in honour of God";

(*b*) That $33\frac{2}{3}°$ south of east is the azimuth of the sun having entirely risen above the Bithynian Mountains at Christmas; and

(*c*) That the church was dedicated to the Second Person of the Trinity, the anniversary of whose birthday occurred very near the winter solstice.

The idea of the $33\frac{2}{3}°$ is thus rendered unmistakably clear: *The sanctuary was to face the sun just risen on the birthday of Christ, to whom it was dedicated.*

Outer Appearance.—Owing to the unrivalled audacity of its construction, as well as to the formidable thrust of its dome, St. Sophia could never have been a really graceful building on the outside. It is even to be feared that, through the still greater flatness of the first cupola, the original form of the church was more disappointing than the present one. Evidently, the early Byzantines attached no great importance to the exterior view of their churches. Outer pomp had to be entirely subordinated to the requirements of inner harmony. All they seemed to have cared for was to have roofs of easy access; and it was doubtless to this end that steep outside curves were assiduously discarded. At the same time, the combination of both outer and inner splendour in the self-same building is a question which the mediæval Greek architects did not attempt to decide. Nor has the problem received a satisfactory solution since their time.

The mortar which covers the brick walls of St. Sophia is doubtless less attractive than the fine naked stone walls of other churches. But while rain and the molecular work of heat and frost tend, in the long run, to decay any stone exposed to their action, the mortar, if only carefully repaired, plays the part of a barb against the disintegration of the active structure beyond. That is why the walls of St. Sophia are still young, though nearly fourteen centuries old; and if they failed on some points, it is to other causes, not to exposure, that the failure ought to be attributed.

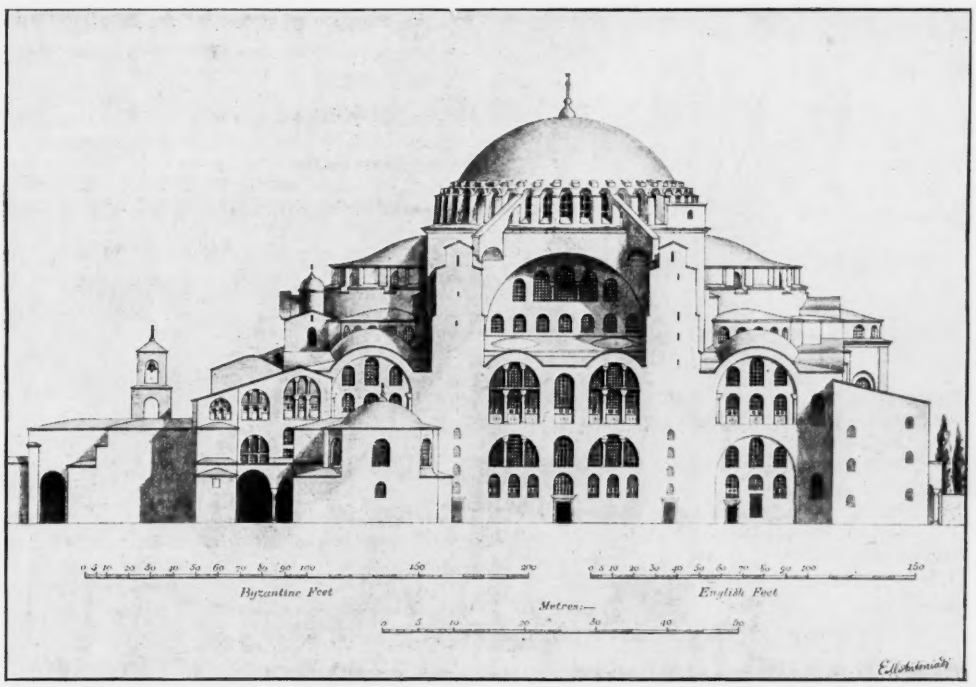


FIG. 3.—The South Elevation of the Great Church. Epoch: 1300 A.D.

A large cross stood at the top of the dome. Indeed, this axiomatic truth would not have been mentioned here were it not to have been questioned by Messrs. Lethaby and Swainson. "Salzenberg," they say, "assumes from Paulus, that 'the dome was surmounted by a cross'; the cross was of mosaic inside."* The authors have been led into error by a misinterpretation of the following verse from the Silentiary's poem:—

75. . . . . Ἀκροτάτης δὲ
76. Σταυρὸν ὑπὲρ κορυφῆς ἐρυσίπτολιν ἔγραφε τέχνη,

* *S. Sophia, Constantinople*, p. 17.

* *S. Sophia*, footnote to p. 160.

which, translated into English, becomes :—

"Above the highest summit art figured a cross, guardian of the city."

Messrs. Lethaby and Swainson remark that "ἔγραφε leaves no doubt that a mosaic cross on the interior is intended."* It is quite clear, however, that the expression "*above* the highest summit" could never apply to an inner cross in mosaic. A real picture is always *on* the surface of the material on which it is depicted; it can neither be *above* nor *below* that surface. Hence no mosaic cross, visible from the floor, could ever have been *above* the spherical surface on which it was drawn; it must necessarily have been *on* that surface. But in the case of a solid cross, erected on the outside, the *above* is welcome, inasmuch as the cross then rises over the outer surface of the dome. These arguments render impossible the meaning of *painted* to ἔγραφε, as, in that case, the painting would have to be effected on empty air, a few feet above the top of the cupola. An English equivalent to ἔγραφε, applicable to a solid cross cast in metal, is *figured;* and, with its adoption, everything is plain sailing. Another argument, but of an indirect bearing on the point at issue, is that a cross on the dome of a great cathedral would guard the city somewhat indifferently if painted in the darkness of a vault. The watch would be much more effective if the guardian could be given a chance of seeing what he was guarding, and be seen from it; the people would rejoice in the idea of seeing their palladium from a distance in the city.

A careful synthesis of historical facts will enable us to undertake a fairly trustworthy restoration of the outer appearance of St. Sophia at one of the most flourishing periods of Byzantine history, at the time of Basil the Macedonian, in the ninth century. Adding the bell tower erected here in 865 by the emperor Michael in order to receive the bells presented to him by the Doge of Venice, and actually seen in position by Grelot towards 1679; restoring the steps of the atrium; liberating the western arch and semi-dome of their additional thicknesses; also giving the west wall† and the dome their original appearance, we unmistakably launch on something like Fig. 2, where the only weak point lies in our ignorance as to the number of arched openings piercing the atrium wall on the west side. A similar treatment of the south façade, but for a more recent date, led the writer to the elevation shown on Fig. 3. Apart from the omission of the buttress masses erected in 1317, this elevation differs from the present view of the mosque in some other particulars, such as the saddle roofs of the little chambers at the buttress tops; the restoration of a room at the top of the staircase on the south-east angle of the great platform; and the insertion of two buttress arches reaching up to the windows of the cupola. It was during the 1847–1849 restoration that the roofs of the chambers were rendered cylindrical; that the corner room and buttress arches were removed, the office of the latter being taken advantageously by a double cincture of iron round the base of the dome.

* *Ibid*, p. 42, note.

† It was thought safe to buttress the dome on the west at an unknown period of the church's history, and this was done by lengthening radially thirteen of the piers between the upper windows. But there was not enough space between the edge of the central western piers and the edge of the west wall, so that the work entailed a thickening of the latter. This thickening is, therefore, not original, and it does not exist to the east, so that its representation in "original forms" of the church by M. Choisy, as well as by Messrs. Lethaby and Swainson, is doubtless attributable to some sort of error.

(To be continued.)

THE CHEMISTRY OF THE STARS.

I.—INTRQDUCTORY.

By A. FOWLER, F.R.A.S.

IT is a striking fact that more is known with certainty as to the substances which help to build up the sun, and the still more distant stars, than of the materials which exist at depths greater than a few miles below the surface of our own planet. As to the interior of the earth, we can in no way examine any portion of it, and can only speculate as to what may be there by reasoning from such facts as the known increase of density as the centre is approached. In the case of the heavenly bodies, however, we have at least the advantage of being able to see them, and it is in fact upon the spectroscopic analysis of the light which they radiate into space that our knowledge of their chemical composition is founded.

The general principles involved in the identification of the substances composing the heavenly bodies may be summed up in a few words. An incandescent gas or vapour sends out rays of light having definite wave-lengths, whether it be raised to incandescence in a laboratory experiment or by the conditions to which it is subjected in sun, star, or nebula; so that all that seems necessary is to find by trial which of the substances open to experiment emits rays corresponding with those of the body under investigation. This analysis of light is of course carried on by the use of a prism or diffraction grating, by which means the rays are dispersed into their component elementary waves, and as the light is usually first passed through a narrow slit, each of these components is represented by a "spectrum line" of definite colour and position. An interesting example of this process is illustrated by Fig. 1, which shows how the presence of helium in Nova Persei, at one stage of its history, was established by comparing its spectrum with that of helium enclosed in an ordinary vacuum tube, and rendered luminous by electric discharges.

D_3.

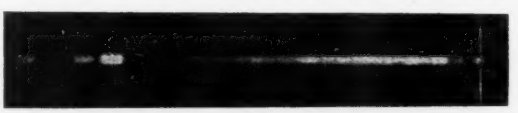


FIG. 1.—Spectrum of Nova Persei, 1901, August 11, with Helium comparison, showing coincidence of the D_3 line. (Lick Observatory.)

Usually, however, the direct radiations of the substances composing the heavenly bodies cannot be observed. Thus, the light of the sun, and of the great majority of the stars, exhibits dark lines on a coloured background when analysed by the prism, but the far-reaching discovery by Kirchhoff that incandescent gases and vapours absorb light of the same wave-lengths as they themselves emit at the same temperature, shows that the dark lines are just as distinctive as the corresponding bright ones, so that the chemical origins of dark lines may be investigated by the process of matching employed in the case of bright lines.* An example of this is given in Fig. 2, which shows how the presence of iron in the sun is demonstrated by the coincidence of numerous dark solar lines with as many bright ones of the metal, the source of light in the latter case being an electric arc lamp having poles consisting of iron rods.

* A general summary of the principles of spectrum analysis, and an account of experiments illustrating them, will be found in KNOWLEDGE DIARY for the current year.

It will be seen that not only is there a coincidence in position of the bright with dark lines, but also a remarkable agreement in the intensities of the two sets of lines—the brighter the bright line the more intense the dark one.

It is quite evident that the chemistry of the heavenly bodies can only be investigated by combining the work of the laboratory with that of the observatory. In the laboratory the spectrum of every known substance must first be carefully mapped out, and the lines tabulated, for ready comparison with the spectra encountered in the observatory. In either case, the most convenient mode of procedure is to record the spectra photographically, as in the two illustrations already given. When a spectrum has been once photographed, it can be re-examined at any time without further experimental preparations, and in some cases, as in that of Nova Persei, a permanent record is secured when the opportunity only occurs once. In dealing with faint objects, the photographic method has the additional advantage of integrating successive impressions, so as to effectively increase their apparent brightness, whereas the eye can only take account of momentary effects of the rays of light, and does not see the lines any brighter by continued observation.

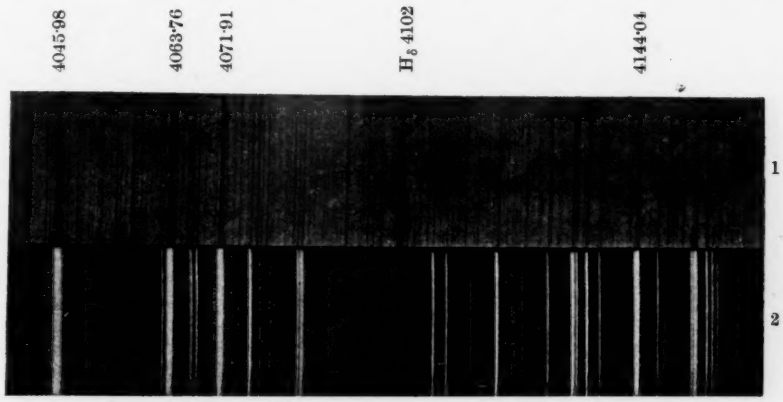


FIG. 2.—A small part of the Spectrum of the Sun compared with that of Iron.

It is scarcely necessary to explain in detail here the methods employed in the practical observation and mapping of spectra, but there is one point of fundamental importance upon which a few remarks may not be superfluous. Although experience may render the observer so familiar with the spectra of different substances that he can often identify lines by mere inspection, careful measurement can usually alone give satisfactory results. It is evidently necessary, therefore, to adopt some system of stating the positions of the lines by which chemical substances are identified, which shall be applicable to spectra observed with any instrument whatsoever, in order that all records may be strictly comparable.

In practice, the positions are stated on a scale of wave-lengths, the number attached to each line then representing the length of the waves of light which produce the line. These waves are excessively small, but they can nevertheless be measured with great accuracy by the use of diffraction gratings. They are so small that the most convenient unit of wave-length—often spoken of as an "Angström Unit"—is the ten-millionth of a millimetre, or "tenth metre," and in this system, the visible spectrum ranges from about 3930 in the violet to 7600 in the red end of the spectrum. Thus, when it is stated that the wave-length of the D_3 line of helium is 5875·98 it is understood that it is that number of times a ten-millionth of a millimetre. It is not necessary, however, to directly determine a wave-length every time that an observation is made, and indeed this cannot be done when a prismatic spectroscope is employed, as is most frequently the case. Certain standard wave-lengths have been carefully measured, and it is usual to determine any required wave-length from these either by inspection or by interpolation. The most generally useful of these reference lines are those given in Rowland's "Tables of Solar Wave-lengths,"* which state with great accuracy the wave-lengths of many thousands of the dark lines which appear in the spectrum of the sun or daylight. In addition to the Tables, Prof. Rowland published a photographic map having a scale by which the wave-lengths can be read off directly with considerable accuracy. Rowland's map is said to be a "normal" one, for the reason that equal distances on the map correspond to equal differences of wave-length, which is not the case with prismatic spectra. A small portion of this map, corresponding in part with the photograph in Fig. 2, is reproduced in Fig. 3, and by comparing the two it will be seen that, although the photographs are not on the same scale, the wave-length of any required line, bright or dark, in Fig. 2 may be read off by the scale in Fig. 3. For example, the three very strong lines of iron, forming a "triplet," near the left of Fig. 2 are clearly identical with the lines 4045·98, 4063·76, and 4071·91 in the solar map. Having a complete set of such maps, it is evidently an easy method of obtaining wave-lengths to photograph the spectrum of sunlight alongside that of the spectrum under examination. Sometimes, however, it is more convenient to use the spectrum of iron as a comparison, in which case reference might be made to the admirable wave-length map of this spectrum published by Messrs. Kayser and Runge.†

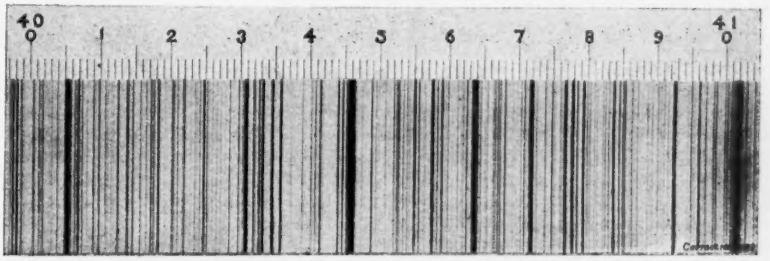


FIG. 3.—A portion of the Solar Spectrum, with Wave-length Scale. (Rowland.)

When no comparison spectrum has been photographed in juxtaposition with that under investigation, and this is

* Published by the University of Chicago Press, 1896.

† *Abh. d. Akad. d. Wiss. zu Berlin*, 1888.

not always possible, the wave-lengths of the lines cannot be determined unless some of them are recognisable by their peculiar groupings, or otherwise. In this case the previous method may sometimes be used by superposing a solar spectrum photographed with the same instrument, or the wave-lengths may be determined by measurement of the photograph, basing the results on the lines which can be identified at sight. One mode of reduction may be illustrated by the use of Figs. 2 and 3. Suppose a finely-divided scale, say a rule divided to hundredths of an inch, to be laid on the bright-line spectrum in Fig. 2, the triplet of iron lines having already been identified in Fig. 3. Now read the positions of these three lines on the scale, and those of any other bright lines for which wave-lengths may be sought. Call the first three readings s_1, s_2, s_3, and the corresponding wave-lengths λ_1, λ_2, λ_3, and solve the equation

$$\lambda = \lambda_0 + \frac{C}{s - s_0}$$

so as to determine λ_0, C, and s_0, by first forming three equations in which λ and s have corresponding values. Then, by using these constants, the wave-length corresponding to any other value of s may be readily calculated. This formula for the calculation of wave-lengths from prismatic spectra was first suggested by the late Prof. Cornu, but has lately become more widely known and adopted through its re-introduction by Dr. Hartmann. It is the equation to a rectangular hyperbola with respect to axes parallel to the asymptotes, λ_0 and s_0 being the co-ordinates of the intersection of the asymptotes, and is based on the supposition that this curve is at least very nearly identical with the curve of dispersion of a prism. The measurements of the photograph must, of course, be made with the greatest possible accuracy, for which purpose a stage micrometer is usually employed.

It is by methods such as these that the tables of wave-lengths of lines in terrestrial spectra, which are indispensable in attempts to identify the chemical constituents of the heavenly bodies, have been prepared. A very great service has been rendered to all engaged in spectroscopic work by Dr. Marshall Watts, who has brought together all the tables of wave-lengths which are scattered through the numerous scientific publications.*

In making use of such tables for the purpose of identifying lines met with in astrophysical investigations, special attention has to be given to the fact that in numerous cases the spectrum of a terrestrial substance varies very considerably with the conditions of experiment. The spectra of metals, for example, may be studied by volatilising them either in the oxyhydrogen flame, the electric arc or electric spark, and very often great differences in the spectra are noted. Magnesium furnishes an interesting example. As will be seen from Fig. 4, the arc spectrum

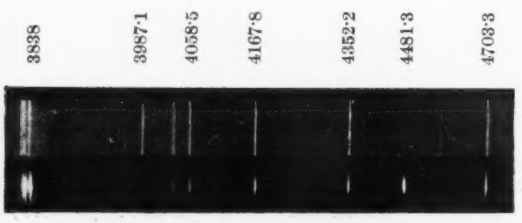


FIG. 4.—(1) Arc, (2) Spark, Spectra of Magnesium.

shows several strong lines, most of which also appear in the spark spectrum, but the latter shows, in addition, a strong line at wave-length 4481·3, a line belonging to the class called "enhanced lines" by Sir Norman Lockyer, since its intensity is increased in passing from the arc to the spark spectrum. On investigating the evidence as to magnesium in the solar spectrum, it is found that while the arc lines are there represented, the enhanced line is conspicuously absent. But if a similar comparison be made with the spectrum of Sirius, the line at 4481·3 is seen to be one of the strongest in the spectrum, while only the stronger of the arc lines are at all represented. It is quite clear then, that comparisons must not be limited to spectra produced under one set of experimental conditions. At times it is even necessary to go beyond our experimental resources to identify the lines met with in some of the stars, and by supposing continuity of change try to define what the spectrum of a substance would be when subjected to temperatures greater than any at the command of the laboratory worker. Thus, in the spectra of such stars as Rigel, there is a line which appears to agree perfectly in position with the above-mentioned spark line of magnesium, but as no other lines of magnesium are certainly present, it is necessary to suppose that the change, partially effected when the spark is substituted for the arc, is completed by the higher temperature of the star.

* "Index of Spectra," and Appendices. Published by Abel Heywood.

THE PATH OF THE MOON.—I.

By A. C. D. CROMMELIN.

THE subject of the Moon's motion is a frequent source of perplexity to students of astronomy; they meet with statements in text-books which at first sight seem incompatible with one another, and are unable to reconcile them. The key to the solution of these difficulties lies in a perception of the fact that all our ideas of motion are essentially relative. If we picture to ourselves one solitary orb in boundless space, the statements that it is at rest or in motion are alike meaningless to us. We must have some point of reference to enable us to estimate any change in its position, and this at once introduces the conception of relative motion. Thus in discussing the motion of the Sun and its attendant planets through space we make the assumption that the group of stars around us has on the whole no tendency to move in one direction rather than another. We thus take the centre of mean position of the group of stars as a fixed point, and deduce the Sun's motion relatively to it. Hence different groups of stars may (and do) give different results for the solar motion, which simply implies that the one group is not at rest relatively to the other group. So in the case of the Moon our ideas of its path depend entirely on the point that we select as our point of reference; there are two points that naturally suggest themselves, viz., (1) the Earth, (2) the Sun. The apparent contradictions that were alluded to above arise from the fact that some of the statements refer to her geocentric, others to her heliocentric path.

Consider the case of a man walking round and round the mast of a ship, always keeping at the same distance from the mast. Then it is a perfectly legitimate statement that his path *on the deck* is a circle described with uniform speed. The words in italics are sufficient to qualify the statement and to indicate the origin from which the motion is reckoned.

On the other hand it is an equally legitimate statement that his path *on the sea* is an undulating or wave-like curve, described with variable speed, greatest when he is walking towards the bow, least when towards the stern.

We can get a good representation of the Moon's path

round the Sun by supposing the man to describe a circle of fourteen feet radius in fifty-nine seconds, while the ship is describing a circle of one mile radius about a light-house, or other fixed point in the sea, in twelve minutes ten seconds. Then the man's path *on the deck* will correspond to the Moon's path round the Earth, and his path *on the sea* to that round the Sun. Two seconds in the model correspond to one day in nature, while one mile corresponds to 93,000,000 miles.

We shall first discuss the nature of the resultant path on the assumption that the orbits of the Moon round the Earth and of the Earth round the Sun are circles in the

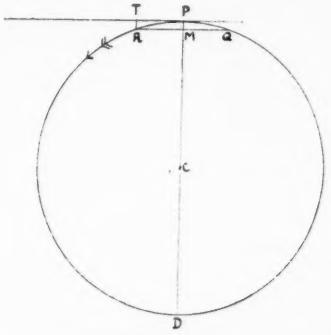


FIG. 1.—The Curvature of the Moon's Path

same plane described with uniform speed, and then pass on to a more accurate description of the nature of the Moon's path round the Earth, indicating a few of the many different ways in which it differs from uniform circular motion.

There is a whole class of curves, known as trochoids, described by points that move uniformly in a circle, whose centre moves uniformly in another circle in the same plane. As all the motions of rotation and revolution in the planetary system (excepting the satellites and probably the rotations of Uranus and Neptune) take place in the same direction, we shall only consider the case where the motion in the two circles is in the same direction. The resulting curves may be divided into the following five groups:—

(1) Those that are wholly concave to the centre of the larger circle.

(2) Those that are just straight at points corresponding to New Moon and concave elsewhere.

(3) Those that are partly concave and partly convex to the centre of the larger circle, the two regions being separated by "points of inflexion" where the curve is straight for a small space.

(4) Those where the points of inflexion coalesce in pairs and form cusps.

(5) Looped paths; these occur when the linear velocity of the point in the small circle exceeds that of its centre in the large circle.

Representatives of all these types, except the second, are to be found in the solar system.

Our Moon is the solitary example of the first type, the only case in which the Sun's attraction exceeds the attraction of the primary.

Phobos, Deimos, Ganymede, Callisto, Rhea, Titan, Hyperion, and Japetus, belong to type (3).

Europa and Dione at certain times conform exactly to type (4), and come to rest at New Moon. At other times they belong alternately to (3) or (5).

Io, Jupiter's Satellite V, Tethys, Enceladus, and Mimas belong to type (5).

The circumstances of Jupiter's satellites have been investigated by Mr. C. T. Whitmell in the *Journal* of the Leeds Astronomical Society, 1901, page 98. His diagram is reproduced by permission from that paper. The path of II. Europa, when it conforms exactly to type (4), is an epicycloid, or figure traced by a point on the rim of a wheel which rolls without slipping round the outside of a fixed wheel. When the fixed wheel is of infinite size, that is when it becomes a straight line, the epicycloid becomes a cycloid; and this is practically the case with Europa, since the path of Jupiter round the Sun is so enormous compared with the path of Europa round Jupiter. It only differs from curve II. on the diagram by having a cusp at N instead of the small loop.

It is not difficult to prove by elementary methods that the path of the Moon is everywhere concave to the Sun. This will clearly be the case if the fall of the Earth towards the Sun in a given time (say one hour) exceeds the fall of the Moon towards the Earth in the same time. The word "fall" here means the amount by which the body is bent away from the tangent to its path by the action of the attracting body in the centre. Thus, let QPRD be the Moon's circular path round the Earth, C, in the centre; P, the Moon's position at any selected time, and PT the tangent to her path at this time. QR are her positions one hour earlier and one hour later, the distance QP, PR being greatly exaggerated for clearness.

Then, clearly, if QR cuts PC in M, QM = RM, and the fall of the Moon in one hour = TR = PM.

Now by Euclid (III, 35) PM.MD = RM.MQ = RM^2. Now since the distance PR is such a small part of the circumference, RM is sensibly equal to PR, and MD is sensibly equal to PD. Hence we have PM.PD = PR^2,

$$\text{or } PM = \frac{PR^2}{PD}.$$

Now PD = 238,818 × 2 miles.

Also the circumference = PD × 3·1416 and the time taken to describe circumference = 27·3216 × 24 hours.

$$\text{Whence PR} = \frac{\text{circumference}}{27{\cdot}3216 \times 24} = \frac{PD \times 3{\cdot}1416}{27{\cdot}3216 \times 24}$$

$$\text{And PM} = PD \times \left\{ \frac{3{\cdot}1416}{27{\cdot}3216 \times 24} \right\}^2.$$

Working this out by logarithms we find that PM = 10·964 miles.

We can find the fall of the Earth towards the Sun in one hour by exactly similar reasoning.

PD is now equal to 92,885,400 × 2 miles; also instead of 27·3216 we now write 365·2564, being the number of days in the year.

Whence fall of Earth towards Sun in one hour

$$= 92{,}885{,}400 \times 2 \times \left\{ \frac{3{\cdot}1416}{365{\cdot}2564 \times 24} \right\}^2$$

$$= 23{\cdot}859 \text{ miles.}$$

We see from this that the fall of the Earth towards the Sun in one hour is considerably more than double that of the Moon towards the Earth. It follows that the resultant fall of the Moon is always towards the Sun, and consequently that her path is everywhere concave towards him. The concavity is, however, very much greater at Full Moon than at New; for in the first case the total fall towards the Sun in an hour is 23·859 + 10·964 miles = 34·823; in the second case it is 23·859 — 10·964 = 12·895, or little more than one-third of the first result.

The resultant velocity in miles per hour is

66576·08 + 2288·38 = 68864·46 at Full Moon.
66576·08 − 2288·38 = 64287·70 at New Moon.

We can now apply the formula found above, viz.—

$$PM = \frac{PR^2}{PD},$$

to find the diameter of the path of the Moon at Full, treated as part of a circle.

For, clearly, PM = resultant fall towards Sun in an hour = 34·823; also PR = resultant velocity per hour = 68864·46.

Whence PD = diameter of path = $\frac{(68864{\cdot}46)^2}{34{\cdot}823}$ miles.

And the radius of path is half this, or 68,091,700 miles.

But the Sun at this distance makes the Earth fall 23·859 miles in an hour. And since the distances have been made the same, the falls are proportional to the masses of the attracting bodies.

Whence

$$\frac{\text{Mass of Sun}}{\text{Mass of Earth + Moon}} = \frac{23{\cdot}859}{10{\cdot}964} \times \left\{\frac{92{,}885{,}400}{238{,}818}\right\}^2$$

= 329,200.

The other result is to find at what distance from the Earth the Moon would have to be for her path round the Sun to be just straight (neither concave nor convex) at

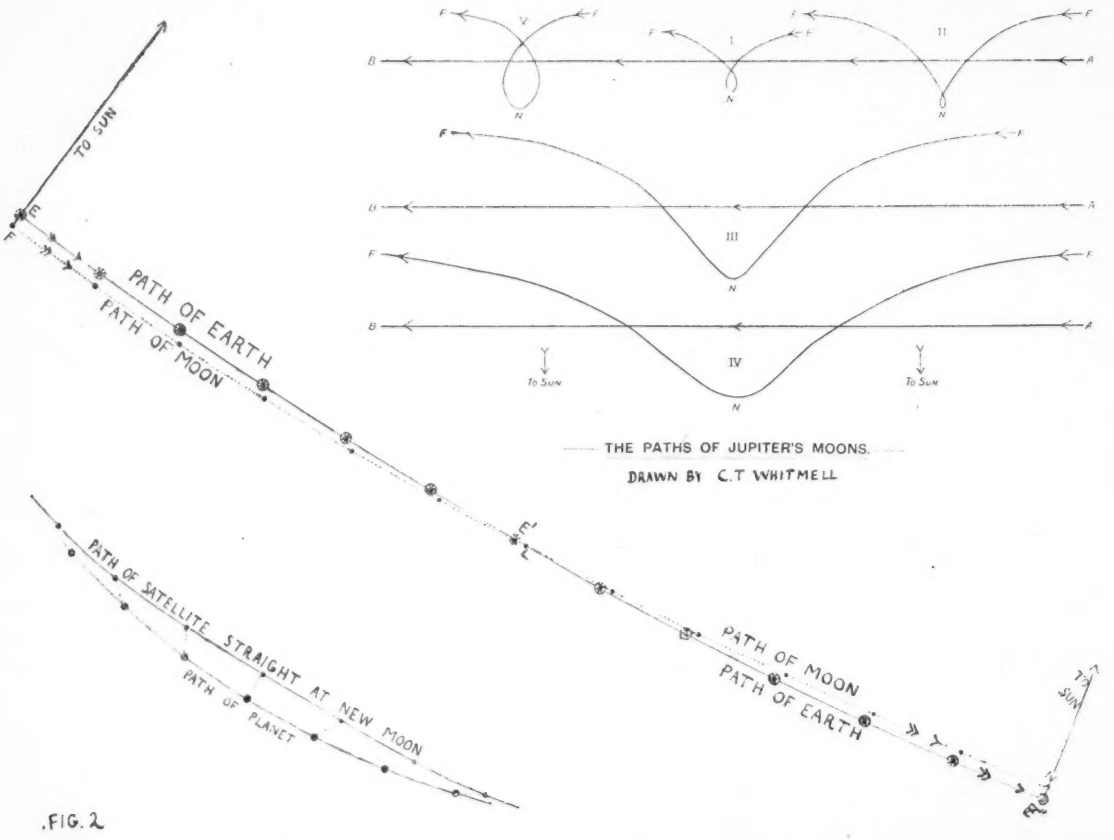


FIG. 2.

In a similar manner we find that the radius of the path of the Moon at New, treated as part of a circle, is

$$\frac{(64287{\cdot}70)^2}{2 \times 12{\cdot}895} = 160{,}252{,}500 \text{ miles.}$$

It is fairly evident that these are the regions of maximum and minimum concavity, and that the radius of the path will gradually increase as we pass from Full Moon to New.

Before passing on from these figures, we shall indicate two other interesting results connected with them.

First we can obtain the mass of the Sun compared with the combined mass of the Earth and Moon. Suppose the Moon were moved to a distance from the Earth equal to the Sun's distance, then her fall towards the Earth in an hour would be

$$10{\cdot}964 \times \left\{\frac{238{,}818}{92{,}885{,}400}\right\}^2 \text{ miles,}$$

since it is inversely proportional to the square of the distance.

New Moon (type (2) given above).

This will clearly be the case if the fall of the Moon towards the Earth in one hour is exactly equal to the fall of the Earth towards the Sun; *i.e.*, we must make the former fall equal to 23·859 miles. But this fall varies inversely as the square of the distance.

$$\text{Hence } \left\{\frac{\text{Required distance}}{238{,}818}\right\}^2 = \frac{10{\cdot}964}{23{\cdot}859}$$

Whence the required distance = 161,889 miles.

This distance is likewise the radius of the sphere over which the Earth holds supreme sway; at its boundary the attractions of the Earth and Sun are equal, while within it the Earth's attraction exceeds that of any other body. All satellites, except our Moon, lie within the sphere over which their Primary rules supreme; this is the reason why their paths in all cases belong to types (3), (4), or (5) given above.

The reader acquainted with the geometry of curves of

higher orders will see that the New Moon point on the curve of type (2) is a point not of inflexion but of undulation, since the tangent here does not cross the curve at the point, as the tangent at a point of inflexion does. The tangent here coincides with the curve in four points, not in three, so that the departure of the curve from a straight line in the neighbourhood of the point is quite insensible. The path of an imaginary satellite conforming to this type is shown on the diagram.

We shall now indicate the manner in which the path of the Moon, or those of the other satellites, may readily be drawn. The scale should be taken as large as possible, and it is impossible to give the entire curve in the case of the Moon on a diagram of reasonable size; it is, however, sufficient to trace the curve from Full to New, the rest of it being composed of simple repetitions of this portion turned alternately backwards and forwards.

For a representation of the Moon's path from Full to New in the pages of KNOWLEDGE, we are restricted to a scale of 7 inches for 15° of the Earth's orbit. This gives us as our maximum available scale one-fourteenth inch for

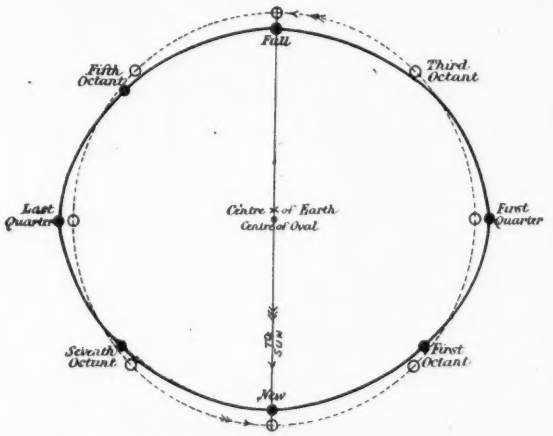


FIG. 3.—The Variation Oval.
○ = Mean Moon. ● = Moon affected by variation.

the Moon's distance from the Earth, and 28·4 inches for the Earth's distance from the Sun. We therefore draw an arc of a circle with this radius, and take a point E on the arc as the Earth's position at Full Moon. The Moon is then at F on the radius produced. The time from Full to New Moon is half of 29·5306 days, or 14·7653 days, in which time the Earth moves through 14° 33½′. Her perpendicular distance from the initial radius is then 7·12 inches, which determines E″ her position at New Moon. The Moon is then at N on the radius through E″. The Moon's path at Full and New Moon approximates to small circular arcs with radii 20·8 and 48·9 inches respectively, these corresponding to the radii found above. Further, at last Quarter we place the Moon at L on the Earth's orbit, one-fourteenth inch ahead of E′, the middle point of the arc EE″. For convenience of subdivision the arc EE″ is divided into 12 portions, each described in about 1¼ days. The dots representing the Moon are placed at a constant distance from those representing the Earth, and revolving round it with uniform angular velocity. The dotted curve representing the Moon's motion round the Sun can then be drawn, and it will be seen that it is concave to the Sun at N, though much more nearly straight here than at F.

Letter.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

THE SOLAR DISTURBANCES OF SEPTEMBER, OCTOBER AND NOVEMBER, 1902.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—From a study of the great solar outburst of last September and the subsequent disturbances of October and November, I have been led to observe certain curious coincidences—to use no stronger term—in regard to the position of some of these disturbances and the order of their appearance on the solar disc. Thus the September outburst, which consisted of a chain of disturbances lying practically along a meridian, and extending from a high south latitude into the equatorial zone of the northern hemisphere, was followed early in October by a group of spots in the *northern* hemisphere and at a distance in longitude of about 180°. Now allowing an apparent or synodic rotation period of 26½ days to the latter group and 27 days to the most important portion of the former, situated about south latitude 24°, we find that October and November gave us repetitions of the above phenomena in a portion of the disturbed area, and that each recrudescence *appeared* to affect a portion of the opposite hemisphere situated at the extremity of a diameter. The same rule also held good in regard to a group of faculæ independent of the above, and which, appearing toward the end of October in the southern hemisphere, had its *vis-à-vis* in November in the northern hemisphere.

If these facts be something more than mere coincidences, do they not suggest the conclusion that in the displays of the last three months we were viewing some of the effects of eruptions deeply seated and powerful enough to shake the whole body of the sun, and to cause great waves to converge at their antipodes, and to excite other eruptions in turn?

Moneybroom, Lisburn, JOHN M. HARG.
16th December, 1902.

NOTES.

ASTRONOMICAL.—In his work on the nebulæ, Sir William Herschel recorded the positions of fifty-two supposed extensive regions of diffused nebulosity. Recognising the great importance of these in considerations relating to the structure of the universe, Dr. Isaac Roberts has made a careful photographic investigation of the regions in question, with the remarkable result that in only four of them has any nebulosity been found, although the photographs show stars as faint as 17th magnitude. One of these four, branching out from ζ Orionis, is of peculiar interest.

The interesting suggestion made by Sir David Gill a few months ago, to the effect that the brighter stars, as a whole, appear to have a motion of rotation with respect to the fainter stars, has been tested at Oxford by Prof. Turner. A relative motion similar to that described by Sir David Gill, and equal in magnitude, was indicated by

a comparison of photographs taken in 1892 and 1902, but the motion was in a contrary direction. It is not impossible, however, to reconcile these seemingly opposed results.—A. F.

Botanical.—The last volume of the *Annales du Jardin Botanique de Buitenzorg* contains a paper by Prof. O. Penzig on the flora of Krakatoa. This, and a paper published by Dr. Treub in the seventh volume of the *Annales*, are especially interesting as throwing some light on the question of the origin of insular floras. Krakatoa lost all its vegetation in the terrible volcanic eruption of August, 1883, which covered the island to a depth varying from one to sixty metres with a bed of red-hot ashes and pumice-stone. Its appearance afterwards, according to Dr. Treub, was that of a mountain isolated in the sea, rising with almost perpendicular sides to a height of 2500 feet. The island, which is 21 miles from Java and 20 from Sumatra, was visited by Dr. Treub in 1886. He found it uninhabited, and not easily accessible. On the narrow beach he found fruits or seeds of 7 species of phanerogams, and young plants of 9 species, all the latter, excepting one grass (*Gymnothrix elegans*), being the usual littoral plants of tropical islands. In the interior the vegetation was quite different—ferns, both in the number of species and individuals, predominating. Dr. Treub concluded that ferns in such a flora precede and prepare the soil for a phanerogamic vegetation. Their minute spores would be brought long distances by the wind, but it was remarkable that these would germinate and develop into plants on the intensely arid soil of Krakatoa. A close examination of the ashes and pumice-stone, however, revealed the presence almost everywhere of Algæ (Cyanophyceæ), coating the soil with a thin gelatinous layer in which the fern-spores would find a suitable place for germination. Besides lower cryptogams, Dr. Treub found, in 1886, 15 phanerogams and 11 ferns. Prof. Penzig's paper records a visit to the island in 1897, made by himself, Dr. Treub, and other botanists. The flora consisted at that time of 62 species (50 phanerogams and 12 vascular cryptogams) belonging to 24 orders. The ferns still predominated in the interior, and several species of tall grasses formed a striking feature of the vegetation. Seeds or fruits of 30 species were found on the beach, and here and there seedling plants, showing that the seeds were capable of germination. Of the 53 phanerogams, Prof. Penzig estimates that 17 were introduced by the agency of the wind, 32 by water, and 4 by birds.—S. A. S.

Zoological.—In a paper on the larvæ of the various species of eel, published in the *Transactions* of the American Philosophical Society, Mr. C. H. Eigenmann discusses the question whether these fishes ever breed in fresh water. Till eggs are actually taken in lakes the question must remain *sub judice*, for, as the author very pertinently remarks, the fact that eels are found in land-locked basins cannot be regarded as an absolute proof that they breed there, although it is difficult to see how they can continue to exist in such situations without doing so.

A small fish from the rivers of West Africa, measuring about three inches in length, and provided with elongated pectoral fins, is in the habit of taking aërial flights after the fashion of the true flying fish and flying gurnards. This fish (*Pantodon bucholzi*) is the only freshwater species known to possess powers of this nature. Although allied to the *Osteoglossidæ*, it is regarded as the representative of a special family—the *Pantodontidæ*. A reproduction of a photograph of this remarkable fish has been recently published by Mr. G. A. Boulenger in *The Field*. In the same journal that gentleman describes an unusually large kind of tadpole from South Africa, measuring five inches in length. Here we may take the opportunity of correcting an error in our December "Notes" column, where the original description of the marine representative of the genus *Galaxias* was accredited to Mr. Boulenger instead of to Captain Hutton. The specimen on which the determination is based was found in the mouth of a larger fish taken off Auckland.

An important memoir on the true seals of the North Pacific and Bering Sea has been recently published by Dr. J. A. Allen in the *Bulletin* of the American Museum. Perhaps the most generally interesting portion of this communication relates to the difference between the dentition of the male and female of the common seal. In the latter sex the teeth are much smaller than those of the male, and are inserted more obliquely in the jaw; they also differ by the reduction in the size and number of the accessory cusps, which are almost invariably absent on the inner side. The author recognises a considerable number of species of Pacific seals, some of which might, however, be regarded by other naturalists rather in the light of local races.

In a communication recently published in the *Revista* of the La Plata Museum, Dr. R. Lehmann-Nitsche doubts the possibility of the survival in South America of the Patagonian ground-sloth, of which the remains were found in such fresh condition in the well-known cavern at Ultima Esperanza. He believes the reports of its existence at the present day to be based on other animals—notably the otter. In the same journal, Dr. S. Roth describes the remains of other mammals found in association with those of the ground-sloth. Among the most interesting of these is the skull of a large jaguar (*Felis listai*), half as big again as that of the living species. The author also describes and figures the foot-bones of four species of extinct American horses, one belonging to the genus *Equus*, a second to *Hippidium*, and the other two to *Onohippidium*. The latter are characterized by their extreme shortness; and if, as appears to be the case, the lateral toes were wanting, *Onohippidium* seems to have become monodactyle independently of the true horses, since its skull is quite different from those of the latter. This is a matter of extreme interest, to which South American palæontologists might well devote special attention.

Hitherto only a single form of the African aard-wolf (*Proteles cristatus*) has been recognised by naturalists. In a recent issue of *Novitates Zoologicæ* the Hon. Walter Rothschild has shown that three local races exist, namely, the typical Cape form, the Angola form, distinguished by its rufous colour and fewer stripes, and the Somali race, characterised by its creamy-white ground-colour and possibly by its small size.

Since the year 1894, Mr. Rothschild has published from time to time, in *Novitates Zoologicæ*, a series of most valuable and interesting notes on giant land-tortoises, mainly based on the specimens in his own collection at Tring and in the Zoological Gardens. One of the most important determinations made by him is the fact that the celebrated Port Lewis tortoise, commonly known as Marion's tortoise, originally came from the Seychelles, and that it typifies a distinct species, *Testudo sumeirei*, characterised, among other features, by the absence of a nuchal shield. During the past year three papers on giant tortoises—one by Dr. A. Günther, and two by Mr. Rothschild—have appeared in the journal already named. In the first of these Dr. Günther describes the shell of a tortoise from Charles Island, in the Galapagos group, which had been made the type of a new species (*T.*

galapagoensis) by the late Dr. G. Baur. It is a member of the so-called saddle-backed group, of which four species are now known, namely, *T. galapagoensis* from Charles Island, *T. ephippium* from Duncan Island, *T. becki* from North Albemarle, and *T. abingdoni* from Abingdon. In one of his two papers Mr. Rothschild describes, under the name of *T. wallacei*, a shell probably from Chatham Island, Galapagos group, which was formerly in Bullock's Museum. The author believes it to be the only known representative of a once common species. We hope shortly to publish an article on giant tortoises.

A correspondent "Adolescens," writes to us as follows:—"I have read that some kinds of bees, flies, and water-fleas, are produced from eggs that have never been fertilised by the male. Is this true? I shall be obliged if you will kindly answer this question in the 'Notes and Queries' of your next issue, and tell me what animals are produced (if any) by parthenogenesis." We can perhaps answer this best by quoting from Dr. D. Sharp, who writes as follows in the first of the two volumes on Insects in the *Cambridge Natural History*:—

"There are undoubted cases in insects of the occurrence of parthenogenesis, that is, the production of young without concurrence of a male. This phenomenon is usually limited to a small number of generations, as in the case of the *Aphididæ* (plant-lice), or even to a single generation, as occurs in the alternation of generations of many *Cynipodæ* (gall-flies), a parthenogenetic alternating with a sexual generation. There are, however, a few cases of insects of which no male is known (in *Tenthredinidæ*, *Cynipidæ*, *Coccidæ*), and these must be looked upon as perpetually parthenogenetic. It is a curious fact that the result of parthenogenesis in some species is the production of only one sex, which in some insects is female, in others male. . . . In some forms of parthenogenesis, the young are produced alive instead of in the form of eggs." It may be added that at least some drone bees are produced by parthenogenesis.

Notices of Books.

"A NATURALIST IN INDIAN SEAS." By A. Alcock, M.B., LL.D., F.R.S. (Murray. 1902.) 18s.—The author tells us in his preface that this volume "is compiled from the records of the Royal Indian Survey Ship 'Investigator'"; but the compilation has been made with such rare skill and judgment that the past lives again in his pages, and the distant is brought near. Hence, we venture to think this book will come to many as a revelation, not only of the methods of marine surveying and zoological investigation, but also of a world of life, kaleidoscopic in its changes, and romantic in its facts. He has conjured up a panorama of the most alluring description: Indian temples and tropical islands, coral reefs and peaceful lagoons, raging seas, and the mysteries of their uttermost depths, are each in turn presented, and their several inhabitants pointed out and described, in such a way that we see them, not as so many ethnological and zoological examples, but as living creatures, leading strenuous lives hitherto undreamt of by the stay-at-home reader—unless he be also a zoologist. If none of the facts in this book are absolutely new it is because they have already been published by the author, and others working out the materials supplied by him, in the pages of the *Proceedings* of various learned societies. Here, however, they were accessible only to the professed zoologist; in their present form, carefully selected and reset, they will be welcomed by the lover of travel and natural history the world over. Of the many remarkable facts recorded in this book not the least interesting are those concerning certain viviparous rays, the young of which are nourished by a secretion, formed by vascular filaments of the oviduct, closely analogous to milk. These filaments, in a small sting-ray (*Trygon bleekeri*) were found "dripping with milk." This is conveyed into the body of the embryo, not through the mouth but directly into the throat through the modified first pair of gill-clefts or spiracles; the milk-secreting filaments passing from the wall of the oviduct into these apertures. The method of extracting the milk by sucking, which prevails among the higher mammals, is here of course impossible, consequently, it is pumped into the gullet by the contraction of muscular fibres investing the filaments in question, a method which recalls the squirting process of feeding which obtains among the marsupials. The absorption of the yolk-sac by the short-tailed bat-ray (*Pteroplatea micrura*) is another extremely interesting instance, affording an instructive illustration of the substitution of organs. This yolk-sac "contained no blood-vessels for absorbing the yolk such as are generally found in all yolk-sacs"—but instead this work was done by the external branchial filaments—the long and delicate vascular processes which later form the external gills, and which later still disappear and are replaced by the internal gills of the adult. Of the weird and wonderful ways of the deep-sea fishes and other creatures, and how they contrive to make life possible, if not worth living, in those regions of eternal night and unbroken silence, Dr. Alcock has much to say, and not a little that is new. Dr. Alcock is inclined to doubt the authenticity of the accounts of the tree-climbing powers of the celebrated robber-crab (*Birgus latro*) which he found in South Sentinel Island. That these stories are probably true, however, we may infer from the accounts published not long since by Dr. Andrews, of the British Museum. On Christmas Island he found these crabs climbing the sago-palms when the fruit was ripe in order to feed thereon. Apparently, some successfully made the ascent, whilst others waited below to feast upon the fruit which had either fallen naturally or had been detached by their fellows up aloft. Musical crabs, fighting crabs wielding ponderous war-clubs, hermit crabs which live in bamboo-stalks, and numerous other remarkable crustacea are vividly described in these pages, together with a host of other creatures, the mere enumeration of which would unduly prolong this notice. Reluctantly we bring this short account to a close, with the conviction that the book will take first rank among those of its kind—and these are many. It is a delightful volume, well printed, well illustrated, handsomely bound, and without a dull page.

"BIOLOGICAL LABORATORY METHODS." By P. H. Mell, PH.D., Director of Alabama Experiment Station, &c. (Macmillan & Co.)—This book combines general instructions for the use of the microscope and its accessory apparatus, directions for imbedding, staining and generally preparing micro-sections, with separate chapters on photo-micrographic apparatus and methods, the study of bacteriology, and the polarisation of light, and concludes with useful formulæ and tables, together with suggestions for the arrangement of the laboratory and its furniture. The hints generally for conducting laboratory work, although suffering from the defect of superficiality, which must of necessity occur where so large an area is covered in a small volume, are concise and in many respects valuable.

The aim of the writer, set forth in the "Introduction," to "deal with facts in a perfectly scientific, accurate manner," is unfortunately unrealised in many of the chapters, and especially is this so when he is dealing with microscopical and general optical principles. The writer assumes, for instance, that a Coddington Magnifier is an Aplanatic Triplet, and further states that the Wollaston Doublet increases the distance between the lens and the object, whereas the reverse is actually the case. The descriptions of spherical and chromatic aberration are both vague and confusing. He states that the method of correcting spherical aberration is to so grind the lens that its curvature at the edge is less than at the centre, presumably referring to a system of "figuring" which is never applied to microscopic objectives; while an achromatic objective is stated to be "so constructed that the coloured rays decomposed out of the white light by the first lens are recomposed by the next lens into white light."

The instructions for the working of the Abbé Condenser, evidently the only condenser known to the author, are vague in description and wrong in practice, the worker being recommended to "stop down" and to control the light by racking it out of focus—a method which was in vogue twenty years ago, when the necessity of focussing the condenser, and the advantages generally derivable from its use, were little appreciated. He further states that "dark ground illumination is obtained by adapting a diaphragm with the opening in the shape of a ring and the centre oblique."

XUM

In treating of the influence of the cover-glass, special emphasis is laid on the effect produced by the variation of thickness of cover when oil-immersion lenses are used. As a matter of fact, these lenses are theoretically least susceptible to this influence, on account of the homogeneity of the medium which forms contact between the front lens and the cover-glass, and herein lies one of the great advantages of oil-immersion lenses.

The description of the polarisation of light is similarly misleading, and the statement is made that the dark field is obtained when the two Nicol's prisms "are *almost* at right angles."

Space does not allow of further extracts, but the book generally leads to the conclusion that the wide range of knowledge which is so essential in those who give directions and advice to others is lacking in the experience of the writer, and that his information on optical subjects has been gleaned from an acquaintance with a very limited amount of apparatus and knowledge of its general principles. There is here material for a really practical and useful book, but the information it gives should be reliable to justify its existence.

"PUBLICATIONS OF WEST HENDON HOUSE OBSERVATORY, SUNDERLAND." No. II. By T. W. Backhouse, F.R.A.S.—Five subjects are included in this most valuable work, which, it should be observed, is not a finished treatise on any one of the sections treated, but a mine from which others may dig the ore that they will mould to their own uses. The sections are:—Part II. of The Structure of the Sidereal Universe; Comets Bernard (1886) and Holmes (1892); The Zodiacal Light; The Aurora Borealis; and Variable and Suspected Variable Stars. In the first section Mr. Backhouse studies the drawings by Easton and Boeddicker, and the photographs by Dr. Isaac Roberts, Prof. Barnard, Prof. Max Wolf, Mrs. Maunder and others published in KNOWLEDGE or elsewhere, and compares the results of various markings or orderings of stars on these with the study of the same regions which he has made visually with a 4¼-inch Cooke refractor. His conclusions are most definite in the regions of the Milky Way, whose effect he judges to be built up for the naked eye by aggregations of stars below the 10th in magnitude. In other regions of the sky he confirms the existence of many streams of stars and rifts, but can come to no definite conclusion as to whether radial series of streams and rifts do actually exist as such or whether they are simple effects due to the accidental crossing of two or more series of parallel streams. In this connection we think some light might be shown by a well-marked feature of many of Dr. Roberts' photographs, namely, the spiral arrangement of curved lines of stars (not nebular spirals), which might well give in some cases the effect of radiating spokes of stars. We do not find that Mr. Backhouse refers to or has studied this spiral formation.

His observations of the place of the Counterglow extend from 1871 to 1895, but he says that, looking at the whole of these observations, it seems impossible to arrive at any conclusion as to the inclination of the Zodiacal Light to the Ecliptic, there being but a very slight preponderance in favour of an ascending node about longitude 10°. The observation of auroræ have become increasingly difficult with the increase in size and the better lighting of the town. His observations tend to confirm slightly the contention of Dr. Veeder, that when an aurora is seen there is a tendency for the phenomenon to recur when the same part of the sun's disc is again presented to the earth; but he thinks that little weight can be given to it as this so nearly coincides with a lunation, which itself gives a false periodicity in the observation of auroræ.

Each section is illustrated by several very fine plates.

"ELEMENTARY PHOTO-MICROGRAPHY." By W. Bagshaw. (London: Iliffe & Sons, Limited. 1902.) Illustrated. 1s. net. —This book, while recognising the advantages derivable from the use of the best means for the work, indicates in a simple yet direct manner how photo-micrography may be done with simple instruments and contrivances, and the use of common sense. Work in such circumstances necessarily has its limitations, but as there is a tendency in the majority of books on photo-micrography to treat the subject as though every worker had the purse of "Fortunatus," it may induce those whose resources are limited to attempt this fascinating work; and not to such alone, but to photo-micrographers generally, this little book will be found to contain many useful hints, based on sound, practical knowledge.

"PRACTICAL PHOTO-MICROGRAPHY." By Andrew Pringle. (Iliffe & Sons.)—This is the third edition of a work which has become a standard on the particular subject with which it deals, and the writer is one who so graphically describes his own practical methods of working as to enable the reader to grasp the directions given and realise the results described. The present issue, which is printed on art paper, and has numerous appropriate illustrations, has been brought up to date in every respect, and the consideration given to the subject of dry plates corrected for colour will be found of special interest. Throughout the book there is no tendency to stint apparatus; it is practically a disquisition on how to do the best work with the best apparatus, although many suggestions to the worker of modest means are given. Photo-micrographers generally will find this new edition of Mr. Pringle's book a valuable help in their work.

"ON AN INVERSION OF IDEAS AS TO THE STRUCTURE OF THE UNIVERSE," By Prof. Osborne Reynolds, F.R.S. Pp. 44. Illustrated. (Cambridge: University Press. 1902.) 1s. 6d.—Whatever may be the ultimate decision as to the validity of Prof. Reynolds's explanation of the nature of the æther and matter, his contribution to the study of this subject must be regarded as of the highest importance. In the little volume under notice, containing the Rede Lecture delivered at Cambridge in June last, we have merely the outlines of a bold theory, the details of which will be published later. The experiments described to illustrate the theory are so remarkable that they alone make the book a desirable possession for teachers and students of physics. Briefly, the view put forward by Prof. Reynolds, and held to be sufficient to provide a mechanical explanation of the phenomena and effects of light and gravitation, is that the æther or medium existing throughout our universe consists of inconceivably small grains. Matter really represents a deficiency of these grains, causing a strain in the medium and thus accounting for the law of gravitation. The grains have diameters equal to the seven hundred thousand millionth part of the wave-length of violet light, and their mean path is equal to the four hundred thousand millionth part of the diameter; their velocity is about one and one-third feet per second. The mean density of this universal medium is stated to be ten thousand times greater than that of water, or four hundred and eighty times greater than that of the densest matter on the earth. The mean pressure is nearly seven hundred and fifty thousand tons on the square inch, being more than three thousand times greater than the strongest material can sustain. From the assumed co-efficient of transverse elasticity of this hypothetical medium the rate of the transverse wave is found to be that of light, while that of longitudinal waves is two and four-tenths greater. It is impossible here to discuss the evidence upon which Prof. Reynolds bases these conclusions, but we do not hesitate to say that, both as regards foundation and superstructure the theory represents an inspiring, if only imaginative, view of the constitution of the physical universe.

"THE DOMINION OF THE AIR; THE STORY OF AËRIAL NAVIGATION." By the Rev. J. M. Bacon. Pp. 352. Illustrated. (Cassell.) 6s.—Mr. Bacon has produced a very interesting and valuable book, in which he describes not only the popular aspects of aëronautics from mediæval times to the present day, but also gives attention to the scientific results which have been obtained. It is a great convenience to have in a compact form a trustworthy account of what has been accomplished in recent years in ballooning and other means of aërial navigation, and to trace the development of the airships from the imaginative structures of Roger Bacon and Father Lana to dirigible balloons like that of Santos Dumont. Mr. Bacon has himself taken no slight part in what may be termed the renaissance of ballooning, and his own observations and conclusions contribute to make his book a noteworthy one. It is usually stated that Lunardi was the first successful aëronaut on British soil, but Mr. Bacon shows that the credit belongs to a Mr. Tytler, who made an ascent on August 27th, 1784, more than a month before Lunardi's aërial voyage from London to Ware. The duration of Lunardi's trip was 2 hours 15 minutes, which is a very good record considering that no free balloon can even now remain aloft for much more than thirty-six hours. There is little prospect of great progress in ballooning as a means of aërial locomotion. By carrying liquefied gas it might be possible to

provide a means of keeping a balloon inflated for six weeks, but even then the balloon would be at the mercy of the wind. Mr. Bacon devotes an interesting chapter to Andrée and his voyages, and in connection with it suggests that in any future attempt to reach the Pole by balloon, wireless telegraphy should be used to maintain communication with the base. Many observations attract attention in reading the book. Glaisher and Coxwell's noteworthy ascents are described and the results summarised. We also find accounts of the work of the French aëronauts, experiments with aëroplanes, and modern airships of various kinds. The book is, indeed, a fair and sufficiently full record of the attempts which have been made to navigate the air; and it will be read with interest both on account of the element of adventure in it and for the information it contains.

"THE COMMON SPIDERS OF THE UNITED STATES." By James H. Emerton. Pp. 225. Illustrated. (Ginn & Co. 1902.) 6s. 6d. net.—Though spiders are not regarded by many people as interesting creatures to study, yet the webs of web-spinning species are sufficient to show to everyone that spiders will repay all the attention given to them. In addition to the family of spiders which make webs to catch insects, there is the family of hunting spiders, which pounce upon their prey from various hiding-places. Mr. Emerton gives a description of the spiders of the United States, with a figure of each species placed as near as possible to the description. The book thus provides a means of identifying spiders, and the numerous beautiful reproductions of photographs of the webs and egg cocoons of various species will be of further assistance in this connection. In an introduction the author describes the parts and characteristics of spiders, and gives useful guidance to the naturalist. It would have added to the interest of general readers if a short account could have been given of instinctive habits and intelligent actions of spiders, such as anyone can easily see, but the book does not on this account lose any of the value it possesses as a guide for the use of students.

"A TEXT-BOOK OF PHYSICS." By Prof. J. H. Poynting, F.R.S., and Prof. J. M. Thomson, F.R.S. "PROPERTIES OF MATTER." Pp. 228. Illustrated. (Griffin & Co. 1902.) 10s. 6d.—It is scarcely necessary to say that students of physics cannot fail to derive benefit from reading this book. The authors are leaders in the field of physical inquiry, and their work reflects faithfully the prominent characteristics of methods, and significance of results, in the ground covered. The volume deals with the fundamental properties of matter which must be understood before much progress can be made in the study of physics. A similar volume on the science of Sound has already been published, and others are to follow dealing with Heat, Light, Magnetism, and Electricity, so that the complete series will provide students with a treatise in which all the main departments of physics will be surveyed. In the present volume, the authors deal with weight, mass, gravitation, and those properties of matter which relate chiefly to change of form, such as elasticity, fluid viscosity, surface tension, diffusion, and solution. The book is characterised by thoroughness, and by the attention given to recent results of permanent value. Traditional ideas as to the order and nature of the subjects to be dealt with in commencing the study of physics—exemplified in the books of Ganot and Deschanel—have not been permitted to control the character of the contents. Early experiments and results have only been used when necessary to illustrate particular points, and discrimination has been exercised in the selection of material from the numerous researches of recent years. The treatment of gravitation is most instructive, and the same may be said of capillarity. Here and there, students not well equipped with mathematical knowledge will find a little difficulty in following the argument, but most of the book is well within the range of every serious student of physics. But though the authors have been successful in their treatment of their subjects, they can scarcely be congratulated upon many of the figures, which are frequently too large and often spoil the appearance of the page. We refer to such illustrations as Figs. 23, 73, 74, 81, 89, 90, 91, 92, and 134. Figs. 27 and 28 are too indistinct to be of any value, and ought to have been omitted if they cannot be made to show up better than they do upon the paper used. Attention to minor matters such as these would have added to the attractiveness of the book.

"THE HEAVENS AT A GLANCE, 1903."—We are glad to see the seventh annual issue of Mr. Arthur Mee's useful little astronomical calendar. He has improved it, in our opinion, by printing it on a smaller card, and on both sides of the card, and by the introduction of a couple of star charts. The smaller map represents the northern heavens as seen from Great Britain, and the larger one the southern. There is also a little key-map to the principal lunar formations.

BOOKS RECEIVED.

Problems in Astrophysics. By Agnes M. Clerke. (A. & C. Black.) Illustrated. 20s. net.

Annual Report of the Smithsonian Institution, 1901. (Washington: Government Printing Office.)

History of Hindu Chemistry. By Praphulla Chandra Rāy, D.SC. (Williams & Norgate.) 12s. 6d. net.

Mont Pelée and the Tragedy of Martinique. By Angelo Heilprin. (Lippincott.) Illustrated. 15s. net.

Modern Microscopy, By M. I. Cross and Martin J. Cole. (Baillière, Tindall & Cox.) Illustrated. 4s. net.

Theoretical Organic Chemistry. By Julius B. Cohen, PH.D. (Macmillan.) Illustrated. 6s.

Preservation of Fishing Nets. By J. T. Cunningham, M.A. (Black.) 1s. net.

Volcanic Studies. By Tempest Anderson, M.D., B.SC., &c. (Murray.) 21s. net.

Simple Experiments in Magnetism and Electricity. By A. E. Munby, M.A., F.C.S. (Macmillan.) 1s. 6d.

Lope de Vega and the Spanish Drama. By James Fitzmaurice-Kelly. (Gowans & Gray.) 1s. net.

Photo Era. Christmas, 1902. 15 cents.

Astronomical Observatory of Harvard College, Annual Report, 1902. By Edward C. Pickering. (Cambridge, Mass.: The University.)

Thornton-Pickard Abridged Catalogue.

Sanitation, Personal and Public. By J. P. Sandlands, M.A., T.C.D. (Elliot Stock.) 2s. 6d. net.

Open-Air Studies in Geology. By Grenville A. J. Cole, M.R.I.A., F.G.S. (Chas. Griffin.) Illustrated. 8s. 6d.

Hazell's Annual for 1903.

British Ornithological Notes.

Conducted by HARRY F. WITHERBY, F.Z.S., M.B.O.U.

On the Occurrence of Phylloscopus viridanus, Blyth, *and other interesting Birds at Scottish Light Stations.* By Wm. Eagle Clarke. (*Annals of Scott. Nat. Hist.*, January, 1903, pp. 22–26.)—Mr. Clarke here gives details of the capture at Scottish lighthouses of a Greenish Willow-Warbler (*see* KNOWLEDGE, December, 1902, p. 278), Lesser Whitethroat, Black-tailed Godwit, and Sooty Shearwater.

The Sooty Shearwater (Puffinus griseus (Gmel.)*) in the Firth of Forth.* By William Evans, F.R.S.E. (*Annals of Scott. Nat. Hist.*, January, 1903, pp. 26–28.)—Mr. Evans is strongly disposed, from personal observation, to consider the Sooty Shearwater a regular, or all but regular, autumn visitant to the Firth of Forth. The only known breeding places of this bird are in the New Zealand group of islands, and Mr. Evans' conclusion of its regular appearance off our coasts points to a regular migration of an almost incredible extent.

Glossy Ibis in Roxburghshire and in Islay. (*Annals of Scott. Nat. Hist.*, pp. 49, 50.)—Mr. Archibald Steel records that an immature specimen of this bird was shot on the Tweed on November 17th last, while Mr. Charles Kirk records that a similar specimen was shot on Islay on October 30th last. The bird has seldom been recorded from Scotland.

Nesting of the Hawfinch in Breconshire. (*Zoologist*, December, 1902, p. 435.)—It has been noted for some years that the Hawfinch is increasing its range westward. In 1890 it was discovered to be breeding in Breconshire, and Mr. E. A. Swainson considers that it is increasing in that county. Last year he found a nest in the west of Breconshire, a point which he considers as possibly the most westerly at which the Hawfinch has been known to breed.

Melanistic Variety of the Water Rail. (*Zoologist*, December, 1902, p. 467.)—Messrs. Williams & Son, of Dublin, note that a Water Rail, shot near Dublin on November 13th, was entirely black, with the exception of the barred feathers on the sides and the under tail coverts, which were dull white. The beak and feet were also black, and the eyes dark brown.

Bullfinch in Shetland. (*Zoologist*, December, 1902, p. 468.)—Mr. T. Edmonston Saxby records that he obtained a female Bullfinch in Shetland on November 8th. This is, it appears, only the second authenticated instance of this bird's appearance in Shetland.

XUM

Winter Nesting of Birds.—At the December meeting of the British Ornithologists' Club, Mr. T. Digby Pigott announced, on behalf of Lord Moreton, that during the week ending November 22nd last a Thrush had hatched out a young one, and a Starling and a Wren had laid eggs at Sarsden, in Oxfordshire. He also reported on the authority of Mr. R. Norton, of Downs House, Yalding, that in the same month there were young Martins in a nest in Kent.

Variety of the Woodcock.—At the same meeting, Mr. W. B. Tegetmeier exhibited an interesting and striking variety of the Woodcock with the ground-colour of a lilac-grey, and the chestnut vermiculations of a bright tint. The ends of the primaries were all white, with the usual black markings replaced by lilac-brown. The under parts were creamy-buff, faintly barred with pale greyish-brown. The throat white; the bill rather paler than usual, but the iris of the normal colour. The bird was a female, and was procured in the Galtee Mountains, Tipperary.

Dotterels in Merionethshire (Ibis, January, 1903, p. 133).—Mr. O. V. Aplin writes to the *Ibis* that he saw Dotterels on a mountain in Merionethshire in May, 1902, as he did in 1901. This bird occurs only occasionally in Wales, but since Mr. Aplin has seen the bird for two years in succession in the same place, it seems that some at all events are regular visitors to the Cambrian mountains. It is also just possible that they remain to breed there; but Mr. Aplin remarks that the birds could not be found in June.

The British Geese (Anser paludosus (Strickl.*) and Anser neglectus).* —Reference was made in the November (1902) issue of KNOWLEDGE to some notes on the British Geese by Mr. Coburn and by Mr. Frohawk. Mr. Coburn now calls attention *(Zoologist*, December, 1902, pp. 441-448) to a bird which he procured at St. Abb's Head, Scotland, on February 25th, 1896. Mr. Coburn somewhat confidently concludes that this bird is the same as that described by Strickland in 1858 as *Anser paludosus*, which Strickland presumed was the same bird as a Goose known to the Yorkshire fowlers of the 18th century as the Carr-lag. Mr. Coburn, as did Mr. Strickland, presumes that this is a Goose of aquatic habits, and so he accounts for its "long swan-like neck and large swan-like feet." Mr. Coburn says that the bird equals a fine Grey-lag in size, but its general tone of coloration of plumage resembles that of the Bean Goose. As regards the structure of the bill the serrations on the lower mandible "are large in size, sharply pointed, and directed backward, whereas in the Bean Goose they are straight, blunt, and more fused together."

Mr. F. W. Frohawk suggests *(The Field*, December 20th, 1902, p. 1045) that a Goose described as *Anser neglectus* by Mr. B. Sushkin *(Ibis*, 1897, p. 5*)* may be found occasionally in Great Britain This bird, Mr. Frohawk says, may be termed the large pink-footed Goose. Its bill is longer and more slender than that of *Anser brachyrhynchus*. Mr. Coburn and Mr. Frohawk are to be thanked for calling attention to these Geese, and it is to be hoped that their observations will lead to further material being collected so that the various species of British Geese can be authoritatively defined.

All contributions to the column, either in the way of notes or photographs, should be forwarded to HARRY F. WITHERBY, *at the Office of* KNOWLEDGE, 326, *High Holborn, London.*

ANIMAL WIND-BAGS—USEFUL AND ORNAMENTAL.—II.

WIND-BAGS AS VOICE ORGANS.

By W. P. PYCRAFT, A.L.S., F.Z.S., ETC

ALTHOUGH, as in the case of the great bustard and the pinnated grouse, the inflation of the air-sacs of the throat is associated with the production of peculiar sounds, caused by the violent expulsion of the air therefrom, the display of these wind-bags is, as a rule, silent. Or the sound is produced by the voice organ and not the sac, which is primarily, among birds at least, an ornamental appendage.

The wind-bags with which we are now to deal are in every instance devoted exclusively to the production of sound, musical or otherwise, which is designed, as in the foregoing instances, to attract and charm the female members of the community. Among the birds, it will be remembered, these peculiar wind-bags are sometimes formed by temporarily commandeering the services of the gullet, sometimes by the development of independent structures, as in the case of the throat-pouch of the great bustard; but the pouches now under consideration are in all cases specially developed organs borne only by the males.

The troubadours of nature are countless, but perhaps the quaintest of these minstrels are those which elect to declare the tender passion on the bagpipes. To our ears the music they produce is often as trying to the nerves as the noise produced by a child with its first drum; whilst in other cases we are charmed with the beauty of the melody. Doubtless, however, to those for whom they play, the music is in all cases equally charming! Among our own species, indeed, the musical sense is by no means uniform. To Europeans' ears, the musical efforts of the savage seem but a jumble of discordant sounds, whilst the productions of Mendelssohn or Beethoven, for example, may stir up the deepest emotions in our nature. In other words:—

"There are nine and sixty ways of constructing tribal lays,
And—every—single—one—of—them—is—right."

So far as we are concerned, the lays now under consideration are expressed in music without words; whilst, as we shall see presently, the peoples who furnish the subjects thereof hold very widely distinct positions in the animal kingdom. Doubtless it will come as a surprise to many to find that the humblest of these performers on wind instruments are to be found amongst the ranks of the much-abused and despised frogs and toads; creatures that for centuries have been looked upon with misapprehension and even loathing. Shakespeare appears to be the only one of the old-time writers who has discovered a single redeeming feature about these really inoffensive

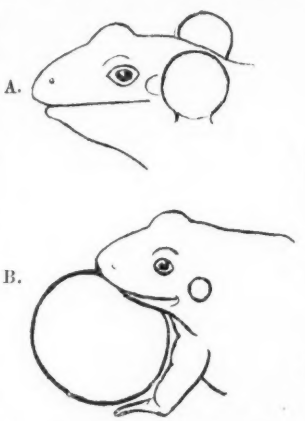


FIG. 1.—A. Paired Vocal Sacs of Edible Frog. B. Medium Vocal Sac of a Tree Frog.

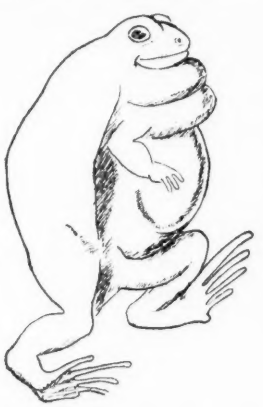


FIG. 2.—Dusky-spotted Marsh Frog of Paraguay, showing Air Sacs. (After Gadow.)

and useful creatures. Thus, in "As You Like It," Act II., he assures us that—

"The toad, ugly and venemous, wears yet a jewel in its head."

Had he been acquainted with the discoveries of modern zoology he might perhaps have added, "and a musical box in its throat."

We of the British Islands are dependent upon an alien for our first-hand knowledge of musical frogs. This is the European edible frog, which is said to have been introduced, many years ago, into the Cambridgeshire fens, and parts of Norfolk, from France. Its performance, however, is, to our ears, rather of the barbaric than the æsthetic order. Nevertheless, in their own way the males of this species appear to be most assiduous musicians, playing out of sheer joy of living, not only during the

period of courtship but throughout the months of June and July. During this season, especially when the nights are warm and moonlit, the concert begins at sunset and continues till dawn. One of these musical evenings, conducted by a colony of these frogs in North Germany, where they are common, has been graphically described by Dr. Gadow. The tuning-up commences, he tells us, with a single note uttered by a few scattered individuals, "qwarr, oo-arr," or "coarx," "qwarr, oo-ar," "coarx." And then the choir-master commences with a sharp sounding "brekeke." This is the signal for the rest to begin, which they do with a will, bass, tenor, and alto, each performer filling his vocal sacs to bursting size, so that these bags look like a pair of floats, one on each side of the head. When several hundreds of these joyous creatures are indulging in this exercise, the din may be heard a mile off. In the Middle Ages it was customary, where these irrepressible creatures abounded, to keep a servant for the sole purpose of breaking up the concert by beating the pond, throwing stones, or otherwise disturbing the meeting! In Foulmire Fen and Whaddon, in Cambridgeshire, these frogs, in their palmy days, earned for themselves the names of "Whaddon organs" and "Dutch" or "Cambridgeshire nightingales."

The voice-pouches of these frogs form, when inflated, as we have already described, a pair of large globular bags, one on either side of the head. They are found only in the males, and are filled through a small opening in the floor of the mouth on each side of the tongue.

The vocal powers of the American bull-frog, a near ally of the edible-frog, are well known. Assembling in hundreds during the breeding season, the males give voice to a croak so loud as to be compared to the distant roaring of a bull, which can be heard, on a still night, for nearly a mile.

The blue tree-frog of Australia sends forth, at one time a croaking sound, at another a noise which has been compared to the barking of an angry dog. Stranger still, Dr. Goeldi, of Para, has recently described a Brazilian tree-frog, known as the "ferreiro" or "smith," which is possessed of a really wonderful voice, making a sound which is compared to the noise made by a mallet slowly and regularly beaten on a copper plate. Regular concerts take place in the forests where these frogs abound, the notes of several individuals varying in tune and intensity. When seized, this extraordinary creature utters a shrill cry which is compared to that of a wounded cat.

Another tree-frog, this time from North America, has a note which resembles a small bell. So, too, has one of the South American toads, its call-note being described as three bell-like notes, the middle one being the highest.

Darwin's narrow-mouthed toad is another species with a bell-like note. This species, by the way, is further remarkable in that the vocal sacs, during the breeding season, are used as a depository for the eggs! The safety of these treasures is of course of immense importance, but this particular arrangement for their security must be an exceedingly inconvenient one for the father of the family, inasmuch as, until the eggs hatch and the young are extruded, he is rendered perfectly dumb!

A remarkable species of frog recently discovered in Paraguay has a cry which has been compared to that of a kitten. The voice is made by alternately inflating the voice-pouches and lungs. When the latter are fully inflated this frog appears to be as big as a golf-ball, but if startled the air is immediately expelled, thereby reducing the body to one-fifth its former size.

Besides the examples we have selected for comment, the ranks of the lowly and much-despised frogs and toads boast many other performers quite worthy of honourable mention did space permit. It must not be supposed, however, that it is they alone who are provided with the curious dilatable sound-boxes; on the contrary, as we shall now proceed to show, they are to be found in various animals, up to the "lord of creation" himself.

Among the birds we have two very striking instances in the ostrich and the emeu. The ostrich, like certain other birds which inflate the neck for the purpose of display only, transforms his gullet, for the nonce, into a sound-producing organ. This is done by the male only, and when challenging another cock, or courting the female. The sound is described as resembling a muffled "boom," and its production is known by English ostrich farmers as "bromming." It can only be made whilst the bird is standing still, but exactly how it is produced is not quite clear. Possibly the huge column of air in the gullet serves in some way as resonator to the voice organ, whilst, on the other hand, the sound may be produced by the sudden expulsion of the imprisoned air.

The emeu, far inferior to the ostrich in many things, has decidedly the advantage in matters musical, inasmuch as it has developed a quite unique form of voice organ. This is formed by a long slit pierced through the wall of the front of the windpipe, near its middle, so as to permit the exit of a large pouch formed by the inner lining of the windpipe, so that the pouch comes to lie between the windpipe and the skin of the neck. Although present in both sexes, this pouch, strangely enough, appears to be used only by the female, who, during the time when the cares of a family weigh heaviest, gives voice to a very peculiar booming sound of considerable volume. That the sound is due to the action of the pouch there can be little doubt, for the true organ of voice in the emeu is of a very rudimentary character.

Voice pouches among the higher animals occur but rarely. Traces thereof are to be found, however, in certain whalebone whales and porpoises, some swine, and the great ant-eater, indicating that at some earlier time these creatures possessed, if not the gift of song, at least the ability to make a noise in the world.

In the common fox two voice pouches of considerable size are found in the larynx, though not large enough to be visible externally. Probably they are to be found in the wolf, hyæna, and jackal also, and aid not a little in the production of the blood-curdling sounds which these creatures are capable of pouring forth.

We meet with them again among the members of the monkey tribe, and in man. Among some of the former these pouches are of enormous size, yet, save in one or two cases, they are incapable of producing any sound which to our ears would be called musical; on the contrary, in many cases they make the night hideous by the most demoniacal of noises.

The howler monkeys of South America have achieved great distinction in this direction. Waterton, in his "Wanderings," writing of the red howler monkey of Demerara, tells us that "Nothing can sound more dreadful than its nocturnal howlings. While lying in your hammock in these gloomy and immeasurable wilds, you hear him howling at intervals from eleven o'clock at night till day-break. You would suppose that half the wild beasts of the forest were collecting for the work of carnage. Now it is the tremendous roar of the jaguar, as he springs on his prey: now it changes to his terrible and deep-toned growlings, as he is pressed on all sides by superior force; and now you hear his last dying moan beneath a mortal wound."

Some naturalists have supposed that these awful sounds, which you would fancy are those of enraged and dying wild beasts, proceed from a number of the red monkeys

howling in concert. One of them alone is capable of producing all these sounds.

The howler monkeys appear to have gone to considerable trouble and pains to produce these extraordinary sounds, for even the bones of the skeleton have been altered in consequence. The resonating voice pouch of these monkeys is formed by an outgrowth of the membrane lining the windpipe; to be more exact, of the inner lining of the larynx, the region of the windpipe which forms the "Adam's apple" in man. It is of enormous size, and to afford it support the bones of the tongue have been induced to form a huge cup-shaped chamber, and to protect this, the lower jaw has further developed abnormally deep sides, so that the long chamber with its thin-walled pouch is most effectually protected.

The man-like apes—the gibbons, gorilla, chimpanzee and orang-utan—are all provided with these peculiar pouches, and all have remarkably powerful voices.

The pouches of the gibbons are relatively small—in one species, the Siamang gibbon (*Hylobates syndactylus*) of Sumatra, they are said to be wanting—but at least two species are capable of producing musical sounds. Thus, the notes of the agile gibbon have been described as ascending and descending the scale, the intervals being exactly half tones. The highest note an exact octave higher than the lowest. The silvery gibbon, Mr. Francis Darwin tells us, sings in a cadence of three notes in true musical intervals, with a clear musical note. The wan-wan gibbon (*Hylobates leuciscus*) is a decidedly less pleasing songster. Dr. H. O. Forbes, in describing this species, which he met with in Java, tells us that in the evening, just about sundown, and again, just before sunrise, the traveller is often startled by the sudden outbreak of what appears to be, now the loud plaintive wailings of a crowd of women, now the united howlings of a band of castigated children. Eventually the harrowed feelings of the listener are relieved by the discovery that these woeful cries are merely the outbursts of a band of monkeys serenading their neighbours.

The gorilla, chimpanzee, and orang surpass even the howler monkey in their ability to make a noise.

The gorilla is described as being able to emit "a terrible yell that resounds far and wide through the forest." The orang in producing high notes thrusts out his lips into a funnel-shape; but in uttering low notes the mouth is held wide open. The chimpanzee, like the howlers, give vent to loud cries, shrieks, and howls in the morning and evening and sometimes during the night, making a noise which can be heard for great distances.

So far, however, we appear to have more information concerning the size and structure of the voice pouches of the large apes than of the noises which they produce. These pouches are formed by outgrowths of a pair of cavities of the larynx or organ of voice known as the ventricles of the larynx. In the gorilla and the orang they are of enormous size. In the former they extend from the throat downwards over the breast to the armpits; whilst in the latter they encircle the neck, so as to give the creature the appearance of wearing a life-buoy beneath the skin. In the chimpanzee these sacs appear to be somewhat less developed, and are three in number, a median and two lateral.

In man himself it is interesting to notice vestiges of these pouches are found within the larynx, behind the "Adam's apple." It is, perhaps, fortunate that they have sunk into desuetude, for one trembles to think of the numerous street cries, brawls, and the efforts of peripatetic orators that even now harrow our feelings, magnified ten-fold by resonators of this description!

A GIANT AMONG SEALS.

By R. LYDEKKER.

FEW generalisations have taken a firmer hold of the popular imagination than the notion that the animals of to-day bear no sort of comparison with their predecessors of the past in respect of bodily size, and that, so far as the giants of the animal kingdom are concerned, we are living in a dwarfed and impoverished world. Like most popular conceptions this idea contains a considerable element of truth mingled with a large amount of misconception. In the first place, there is no accurate definition of what is meant by "the past." If it mean only those epochs of the earth's history previous to the advent of man, it is unquestionably inaccurate. If, on the other hand, it also embrace the prehistoric portion of man's sojourn on the globe, it has scarcely a claim to be regarded as a fair or accurate statement of the true state of the case, seeing that the extermination of a very considerable percentage of the large animals of the epoch in question has been the work of man himself—a work, unhappily, which is still proceeding apace.

But in addition to this, the animals of one geological epoch are very frequently confounded with those of another, so that dinosaurs and mosasaurs, ichthyosaurs and plesiosaurs, mastodons and mammoths, and glyptodons and ground-sloths, are often spoken of as if contemporaries and inhabitants of the same country.

If such were really the case, we should indeed be living in an impoverished epoch of the world's history; but if we take the term "present" in not too narrow a sense, and also bear in mind that Europe, and such other parts of the world as have been more or less thickly populated for untold ages, scarcely form a fair basis of comparison, it will be manifest that the idea in question is to a considerable extent due to misconceptions and inaccuracies of the nature of those referred to above.

It is true that in certain portions of the world the larger forms of animal life disappeared at an epoch when man can scarcely be regarded as having taken a prominent part in their extermination; a notable example of this kind being South America, where the huge ground-sloths, toxodons, and macrauchenias of the latter part of the Tertiary epoch disappeared with seeming suddenness in what is to us an unaccountable manner. The extermination of the mammoth, the woolly rhinoceros, and the hippopotamus from Europe, although partly, perhaps, attributable to climatic change, has not improbably been accelerated by man's influence, and the same may be true with regard to some of the larger mammals of ancient India.

In the latter country we have, however, still the Indian elephant, the great one-horned rhinoceros, and the wild buffalo, which, although not actually the largest representatives of their kind, are still enormous animals. In Africa the prevalence of animals of large corporeal bulk is more noticeable. Although the extinct elephant of the Norfolk "forest-bed" is stated to have been the biggest of its tribe, it is very doubtful if it was really larger than the living African elephant; and the so-called white rhinoceros, in the days of its abundance, was certainly not inferior in point of size to any of its extinct relatives. The giraffe, again, which in the Mount Elgon district is stated to tower to twenty feet, is much taller than any extinct quadruped yet known to us; and the hippopotamus falls but little short of its ancestors of the Pleistocene epoch. The elands, again, are by far the largest of antelopes known at any period of the earth's history; and the ostrich, although not comparable with some of the New Zealand moas (which, by the way, were probably exter-

minated only a few centuries ago by the Maoris), is yet the largest member of its own particular group. Again, no fossil ape is known which is anywhere in the running as compared with a full-grown male gorilla. It is, moreover, probable, despite the old-world legends of giants, that man at the present day is, on the whole, a taller and finer animal than he ever was before.

Of course there are certain cases where the animals of to-day cannot compare with some of their predecessors, and a case in point is afforded by the extinct atlas tortoise of Northern India, which (although its size has been vastly exaggerated) far exceeded in bulk its living cousins of the Galapagos and Mascarenes. This, however, may perhaps be accounted for by the larger area of its habitat.

Among the inhabitants of the ocean we shall find even more striking testimony as to the large bodily size (either absolute or relative) attained by many animals of the present day. Probably no mollusc was ever larger than the giant clam, whose valves measure a yard or more in length; and we have no evidence that the enormous cuttles and squids, forming the food of the sperm-whale, were ever rivalled in size during past epochs. The huge long-limbed crab of the Japanese seas, and the cocoa-nut crab (which is but a marine creature that has taken to a terrestrial existence) of the islands of the Indian Ocean, are likewise probably the giants of their kind. At no epoch of the earth's history have we any record of an animal approaching in size the blue rorqual, with its length of between eighty and ninety feet, and its weight of, probably, at least as many tons. The sperm-whale and the Greenland right-whale were, at the time of their abundance, certainly the largest of their respective kinds; while the basking-shark has probably been unequalled in bulk by any of its predecessors. The great white shark of the present day is indeed considerably inferior in size to its cousins whose teeth now strew the floor of the Pacific, but these latter lived at no very distant period, and may possibly still survive. Walruses were never larger than they are at the present day, and the dugongs and manatis of the seas of our own days were fully as large as any of their ancestors of which we have ken; while the northern sea-cow of Bering Sea—exterminated only a century and a-half ago—was in this respect far ahead of all other competitors.

The same is true with regard to the anima forming the subject of the present article—the sea-elephant, or, better, the elephant-seal—which so vastly exceeds in size all other members of its tribe that even the largest sea-lions and walruses, when placed alongside its huge bulk, look dwarfs by comparison. But it is not only from its vast size that this seal is of more than ordinary interest, since it is remarkable for many peculiarities in structure and habits, approaching the eared seals (or sea-lions and sea-bears) more closely than is the case with any other of the true or earless seals. It has also, unhappily, an interest attaching to it on account of its impending extermination.

Elephant-seals frequent the shores of many of the islands of the South Seas, where they spend a long time on land during the breeding season, and also occurred formerly on the Pacific Coast of North America from Cape Lazaro to Point Reyes, California, where they are now practically extinct. As these Californian elephant-seals were completely isolated from those inhabiting the South Sea Islands, they are regarded by American naturalists as constituting a species by themselves; but since their distinction from the typical southern form is but slight, it seems preferable to look upon them in the light of an isolated local race. These seals never appear to wander south to the Antarctic pack-ice.

Our first definite, if not actual, knowledge of the elephant-seal seems to have been derived from a specimen brought to England by Lord Anson in 1744 from the island of Juan Fernandez, and the figure and account given in the "Voyage Round the World" of that great commander, where the species is called "sea-lyon." Lord Anson seems to have obtained a male and a female specimen ("lyon" and "lyoness" he calls them), the former of which was stuffed and exhibited in the British Museum. What its dimensions were is now unknown, a somewhat unfortunate matter, since it was probably a full-grown adult male of larger size than any, or the majority of those, to be met with at the present day. After being exposed in the Museum galleries for considerably more than half a century, probably without any protection from dust and the still more mischievous hands of visitors (who then, as now, doubtless displayed an irresistible impulse to handle every accessible object), the specimen must certainly have shown marked signs of wear and tear. Anyway, if we may judge by the fact that the jaws and teeth, which had been mounted in the skin, were sold by the Museum to the Royal College of Surgeons in 1809, the specimen appears to have been destroyed early in the last century. The aforesaid jaws and teeth are still preserved in the Museum of the College of Surgeons.

Although many years later a female skin, presented by the Admiralty, was mounted and exhibited, from the date of the destruction of Lord Anson's specimen the British Museum till quite recently had no example of either skin or skeleton of an adult male of this giant seal to show the public. The deficiency has been made good by the generosity of Mr. Walter Rothschild, and the mounted skin and skeleton of two nearly adult males are now exhibited in the same case. Unfortunately, the taxidermist has not been as successful as he might have been in the mounting of the skin, but nevertheless the specimens suffice to convey an adequate idea of the huge bulk of the creature, and the leading peculiarities of its form.

It may be mentioned here that Anson's figure and description afforded to Linnæus his only knowledge of the species, and upon this evidence was established his *Phoca leonina*, the specific title being the equivalent of Anson's "sea-lyon." As the real sea-lions are totally different animals—eared-seals, in fact—it is a great pity that this name was ever given, but, as being the earliest, it has to stand, and cannot be replaced, as proposed by some writers by the more appropriate *elephantina*. As the elephant-seal differs very widely from the common seal and its immediate relatives, it could not, of course, with the advance of zoological science, be suffered to remain in the same genus, and it accordingly now typifies a group by itself under the name of *Macrorhinus leoninus*.

The generic title *Macrorhinus* refers to the most distinctive feature of the species, the peculiar trunk-like form of the muzzle of the old males. Not only do the male and female elephant-seal differ in regard to the form of the muzzle (the trunk being undeveloped in the last-named sex), but there is also a vast inferiority in the size of the latter as compared with the former. So marked, indeed, is this discrepancy, that an early observer is stated in Weddell's "Voyage" to have mistaken the two sexes for mother and young.

From the testimony of old "beach-combers" and others who have hunted them in their native haunts, it seems evident that the dimensions now attained by sea-elephants fall far short of those reached in the old days, when they abounded on the islands of the South Seas, and were permitted to grow to their full size. In the majority of text-books twenty feet is given as the length of the species; but it is definitely known that specimens at the present

day frequently reach or exceed this length, and as none of these (as exemplified by the condition of the bones in the British Museum and other skeletons received of late years in England) appear to be fully adult, it seems well-nigh certain that old bulls must have grown to much greater size. Probably twenty-five feet would not be an undue estimate for the length of an adult male, and it is far from improbable that close upon thirty feet may have been reached in some cases.

Among the favourite haunts of the elephant-seal were the islands of the Crozet group, Kerguelan, and St. Paul, in the Indian Ocean, as well as Heard Island. In the South Atlantic these monsters formerly abounded on Tristan-da-Cunha, and nearer the American coast they are again met with further south on the Falklands, South Georgia, and the South Shetlands. On the eastern side of the Pacific they occur, as recorded by Lord Anson, on Juan Fernandez, and thence by way of the Marquesas to the Macquarrie and other islands south of New Zealand, where the British Museum specimens were obtained. They were likewise common on the coasts of Tierra del Fuego and Southern Patagonia; and the occurrence of the isolated colony north of the equator in California has been already mentioned.

The trunk-like muzzle of the old bull sea-elephant, like the sac on the crown of the head of its relative the bladder-seal, is capable of inflation during periods of excitement, but at other times is small and relatively inconspicuous. Probably it is only when the animals are on shore, and more especially during the breeding season, that the trunk is inflated to its full extent. The sketch in Lord Anson's "Voyage," although true to nature in some respects, is in many ways a caricature, and it is only of late years that photographs have been obtained showing the true form of the animal. From these it appears that when on land the old bulls are in the habit of supporting the fore part of the body on the front flippers and raising the neck and head into a nearly vertical posture, so that the latter is fully six feet above the ground. When the trunk is inflated to its fullest extent, the mouth is opened, and the animal emits a succession of terrific roars, which may be heard for miles.

In using its front flippers as a means of support to this extent, the elephant-seal is quite unlike the rest of the earless seals, and resembles the sea-lions and sea-bears. It also agrees with the latter group in the great superiority of the males to the females in point of bodily size. A third point of resemblance between elephant-seals and eared-seals is shown by their breeding habits, which are in many respects similar. On the Crozet Islands, for example, where they arrive about the middle of August, the old bulls secure a station for themselves. They do not, however, pass any long period without taking food, neither do they collect "harems" for themselves after the manner of the sea-bears and sea-lions; the females selecting a station for themselves some distance away. Soon after landing the females give birth to their young, which are at first black, and, although there is some discrepancy between different accounts, it seems probable that both sexes remain with their offspring till the latter are ready to enter the sea, which they usually do when about six or seven weeks old. When they have once taken to a maritime life the young sea-elephants are said to grow at a prodigious rate; and, indeed, unless they take many years to attain full maturity, this must necessarily be the case.

As just indicated, the few accounts that have been given of the breeding habits of these seals by no means accord with one another, and this is the more to be regretted since, owing to the comparative scarcity of the species at the present day, it is very unlikely that an authentic history will ever be given to the world.

The extermination of this giant seal, so far as it has as yet gone, is a sad story, accompanied as it is by details of revolting and fiendish cruelty. In the eighteenth and the early part of the nineteenth century these seals were met with in thousands on most of their island haunts as well as on the shores of Patagonia, but the ease with which they could be killed, and the value of their hides and oil, soon led to a vast reduction in their numbers; and in many of their old breeding-places, such as the Falklands, they are either very scarce or are altogether exterminated. On Heard Island they still survive in considerable numbers owing to the difficulty of gaining access to their favourite breeding-ground, to reach which from the shore two glaciers have to be crossed. The difficulty of removing the oil and hides from such a locality has, however, been to a considerable extent overcome by driving the seals to sea during stormy weather, when they are compelled to seek an easier landing-place. In the Macquarrie Islands elephant-seals appear to be still obtained in considerable numbers, but the difficulty, or impossibility, of obtaining a fully adult male tells its own tale as to the persecution to which the species is subject; and it is only too palpable that long before the middle of the present century elephant-sealing will have been abandoned as an unprofitable trade; but by that time we shall really be living in an impoverished world, so far as large animals are concerned.

MICROSCOPY

Conducted by M. I. CROSS.

NOTES ON THE COLLECTION, EXAMINATION AND MOUNTING OF MOSSES AND LIVERWORTS.

By T. H. RUSSELL.

The following notes, which simply represent the conclusions drawn from a good many years' practical observation and experience, and do not pretend to anything more abstruse or scientific, are written in the hope that they may not only prove of service to others interested in the above fascinating little plants, but may also be the means of eliciting further information on the subjects of which they treat from those whose researches have been more extensive than my own. For the sake of convenience I shall only directly refer to mosses, though all that I have to say will apply equally to the liverworts.

I.—COLLECTION AND EXAMINATION.

The appliances for the collection of specimens are simple in the extreme. For many years I have been in the habit of putting the material gathered in the field into old envelopes that have been cut open at the narrow end instead of at the side. Not only do these form the most convenient pockets for the purpose, but notes can be made on them at the time, of the date and locality, when and where the plants were found, and rough memoranda may be added afterwards of any special features of interest that present themselves on a closer examination of the contents, and that need elucidation. A bundle of these envelopes, with a fairly strong magnifying-glass, an old knife, and a pair of forceps constitute my usual outfit, and are kept ready for use in a small satchel, which serves as a receptacle for the envelopes when filled. The forceps are useful for detaching plants from their surrounding earth, an operation that can often be best performed when they are freshly gathered. On reaching home the envelopes that have been used are placed in a warm room, in an upright position, and with the ends opened as widely as possible so as to admit air, and thus to allow

the specimens inside to dry, a matter of no small moment if the risk of mildew is to be avoided. After standing thus for a few days the envelopes can be safely folded over at the ends and put away until a convenient opportunity occurs for examining the contents, when soaking in hot water will speedily restore the plants to their original freshness, though not, of course, to life. The ease with which mosses can in this way be revived for examination constitutes, to my mind, one of the chief attractions which this branch of botanical research offers to anyone in search of a hobby, for while the gathering of specimens forms a healthy out-door occupation for all seasons of the year, and adds immensely to the pleasure and interest of a ramble in the country, their examination and mounting may be deferred for any length of time, and will provide the most pleasurable recreation by the fireside in the long winter evenings, and will bring back the memory of many a happy day in the woods and fields.

The nature of the apparatus used in the examination of specimens will, to a large extent, depend upon the views and means of the student. A microscope of some kind is essential if the study is to be followed up with any degree of thoroughness, though much good work may be done with a comparatively inexpensive instrument; at the same time it is no doubt true that, within certain limits, the better the implement the better the results to be obtained by its use. My own experience would lead me to say that, if the funds will allow, the binocular model is greatly to be preferred to the monocular, if only on account of the saving of strain to the eyes that is thereby effected. Objectives of high power are seldom required; I generally work with 2 in., 1 in., and ½ in. lenses, to which may be added a 3 in., which is especially useful in the exhibition of slides. To prepare specimens for examination or for mounting, some form of dissecting microscope is practically a necessity. For many years I used an ordinary magnifying-glass, of low power, fixed in a light metal frame, at one end of which was a small collar, which slipped over a screw fixed in an upright position in a small metal stand, and provided with a nut by means of which the lens could be fixed in a horizontal position at any required height, and this simple expedient is still often very serviceable. As a rule, however, I now employ the more modern binocular form of dissecting microscope, which is also of the greatest assistance in mounting. For soaking the mosses in hot water I have found nothing so handy as the small china saucers, made in different sizes, and sold by artists' colourmen. For dissecting purposes ordinary sewing needles set in cedar pen-holders are useful in the more delicate work, and it is well to have one or two bent at an angle to the holder, for the purpose of altering the position of objects under examination after the cover-glass has been put on; these, moreover, will be found invaluable in subsequent mounting operations. . In order to bend a needle into almost any form it is only necessary to heat it in a spirit lamp to a red heat, and then plunge it into water, this will render it soft and pliable. The best dissecting implements, however, for ordinary work that I know of are made by fixing glovers' needles into handles in the above manner. I use Mogg & Co.'s glovers' needles, No. 4. They can be obtained at a small cost at any drapers, and are not only provided with a fairly good point, but are ground with three flat faces, thus giving as many cutting edges, by the help of which the specimen can be most effectually prepared for examination and mounting. A pair or two of forceps (one with curved ends), a pair of small scissors, a small camel's-hair brush, and one or two small lancets will practically complete the implements required for all ordinary dissecting, to which must be added, for the purpose of microscopical examination and subsequent mounting, a stock of the usual glass slips (3 in. by 1 in.), and a few sizes of cover-glasses. With many of the larger mosses the square cover-glass (⅞ in. and ¾ in.) is best, as it gives more mounting surface, while for the mounting of pieces of moss of considerable size, cover-glasses that are specially large should be procured.

(To be continued.)

PHOTOGRAPHY OF OPAQUE OBJECTS.

By FREDERICK NOAD CLARK.

(Continued from page 20.)

Perhaps the most useful all-round objective for this work is the 2-inch; a lower power than this we have found of no advantage when depth of focus is an object. The use of a stop in the form of an iris diaphragm or a Davis' shutter is sometimes necessary, it being fitted just above the objective. This will increase the depth of focus when photographing spherical objects or those lying in different planes; but the exposure is necessarily prolonged.

A plate giving the maximum amount of density is necessary. For this purpose any of the well-known makes of isochromatics are best. They must invariably be "backed." The developer should be dilute, and if pyro-soda is used (which we recommend) the pyro should be used sparingly. Development ought to be slowly carried on to full density, the aim being to obtain a negative with plenty of contrast, without blocking of the high lights. It is to give this effect that the backed plate is so essential.

As to length of exposure no exact information can be given. As a rough guide it has been found that using a 2-inch objective with direct illumination by means of the bull's eye from a good paraffin lamp with a 1-inch wick, the exposure at 20 diameters will vary from 2 to 3 minutes according to the colour of the object; a white object naturally requiring a less exposure than a darkly-coloured one. As further examples we may mention those of Foraminifera at 8 diameters with a 2-inch requiring 30 seconds exposure, whilst Polycistina at 45 diameters and a 1-inch objective required 30 minutes.

When photographing objects too large for the field of a micro-objective, lenses of the Planar type will be found convenient. These, in conjunction with a long-extension camera, will give a magnification of from 2 to 10 diameters.

The eggs of insects, particularly those of the Lepidoptera, lend themselves admirably to photography. Especially suitable are those of the Lycaenidæ, or blue butterflies, their small size and elaborate structure rendering them most beautiful objects for opaque photography.

We would impress upon the worker the advisability of photographing these objects at the same magnification whenever possible, in order to give a proper idea of their relative sizes. Two or more aspects of the same object are sometimes desirable, as in the case of ova, where an upright and a lateral view are frequently of importance.

Many other subjects for opaque photography might be mentioned, such as the hairs and seeds of botanical specimens, fern spores and micro-fungi, whilst some of the larger Diatoms, Foraminifera, and Polycistina are eminently suitable for this class of work.

WORKING WITH A POLARISCOPE.—The number of microscopists who use the polariscope for scientific work is exceedingly limited, by comparison with those who find in this adjunct a never-failing source of pleasure and variety, but whether it be used for colour effects or for scientific observations, there can be but one opinion as to the disadvantages produced by the prisms, and particularly when the analyser is used over the eyepiece. It seems well-nigh impossible to get a prism of moderate size which will fill the whole field of the eyepiece, and there is invariably a disagreeable dark patch on the margin of the field. Further, the necessity of working with the eye some distance from the eyepiece lens reduces, in some measure, the sharpness of effect.

In a lesser degree, the polarising prism interferes with the best performance of the substage condenser, and working is practically limited to condensers having small lenses, otherwise the prism would act as a diaphragm.

Mr. E. M. Nelson communicated a special note on this subject to the April (1902) *Journal of the Royal Microscopical Society*, and therein indicated the advantages of using tourmalines instead of prisms.

One tourmaline (which need not be of best quality), measuring about 4/10th by 6/10th, should be mounted in a metal screen, with an aperture of such a size as to prevent any light passing from the lamp, except through the tourmaline. This screen may be held on a separate stand, or in an extra frame attached to the lamp chimney. This would act as the polariser, and the image of the lamp flame could be focussed with the condenser, in the usual manner. Another tourmaline, which must be as perfect as can be obtained of "smoky tint, with the slightest dash of pink," is fitted over the eyepiece. With this in use, the best effects obtainable with the polariscope will be obtained,

XUM

the highest powers can be used, and no deterioration in definition will result. Those who may not think it necessary to go so far as is here suggested, may with advantage fit a tourmaline over the eyepiece only to act as the analyser, and this will polarise perfectly well in conjunction with a prism in the substage.

Tourmalines have not been generally employed on account of the difficulty of securing suitable pieces and the high cost of such; but if a general demand were to arise there is no doubt that with an effort it could be met. It should be emphasised that the plate used over the eyepiece if at all thick or dark will materially diminish the brightness of the image. Poor tourmalines will polarise, but without that brilliance which adds to the beauty of the effects.

Mr. Nelson particularly points out that an apochromatic condenser should not be used in polariscopic work, because the fluorite, which is used in its construction, will also be polarised.

NOTES AND QUERIES.

J. Hills.—Mr. Mason, of 69, Park Road, Clapham, S.W., supplies specimens ready prepared for mounting. If you applied to him for a list you would no doubt be able to obtain what you required.

P. B. Gray.—It is almost impossible to identify the specimen you describe and sketch without actually seeing it, but it probably is *Anobium paniceum*. This is a common pest in stores, &c.

General Warrand.—The specimen you describe and sketch is no doubt the test of the Rhizopod *Arcella vulgaris* or *A. discoides*. The best cement to attach ordinary glass cells to slides is either gold size, Hollis's glue, or Miller's cement. The permanence of the preparations depends on the finishing varnish which you use. Mr. Rousselet has given many years of experiment to this particular subject, and he now recommends that the closing of the cells should be first with a coat of a varnish consisting of two-thirds damar in benzole and one-third gold size, then two coats of pure shellac dissolved in alcohol, and finally four to six coats of pure gold size. Each layer of cement must be allowed to dry thoroughly well; three days for each layer is not too long.

W. D. Dade.—The specimens of which you send a sketch for identification are probably *Hemiophrya benedeni Fraip.* It appears to be a salt-water Infusorian.

W. P.—The most complete work for naming Diatoms is Schmidt's Atlas. This has been published in separate parts, which now number sixty. The value of this work is between £15 and £20, according to its state of preservation. A less expensive book is Van Heurck's "The Study of Diatomaceæ," translated by Mr. Wynne E. Baxter. The price of this is 50s.

J. E. Storey.—It is almost impossible to indicate in print tests for objectives of larger aperture such as you possess, because some workers are able to do so much more with their lenses than others, and it would probably happen that you would still be in possession of good objectives even if you could not accomplish the same work as others. Experienced workers can usually form a very accurate opinion of a lens with simple rather than extreme tests, but it would be impossible to give reasons for deductions in a reply such as this. Perhaps some reader may know the refractive indices of Farrant's medium, glycerine jelly, and acetate of copper solution.

Rev. S. R. Craig.—Notes from time to time appear on photo-micrography, and an attempt is being made at present to give hints on aspects of the subject which are not usually treated. I may be glad of the loan of your photographs at a subsequent date.

W. H.—To mount vinegar eels (*Anguillula aceti*) add a little chloroform to the vinegar to kill the eels. When the eels have settled to the bottom of the bottle, pour off the vinegar, and add camphor water or carbolized water. Mount in a shallow cell in the same fluid.

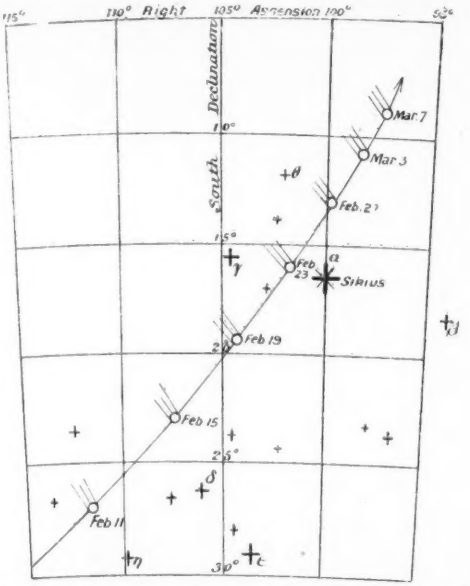
CONSULTANTS.—I shall be very glad of the assistance of a reader in the naming of polyzoa, algæ, etc.

Communications and enquiries on Microscopical matters are cordially invited, and should be addressed to M. I. CROSS, KNOWLEDGE *Office, 326, High Holborn, W.C.*

NOTES ON COMETS AND METEORS.

By W. F. DENNING, F.R.A.S.

PERRINE'S COMET (1902 B).—This comet will be visible in the evening sky before moonrise on February 13 and ensuing nights. Towards the end of the first week in March moonlight will obliterate the object, and it will hardly be seen again in ordinary telescopes owing to its rapid decline in apparent brightness. At about the middle of February the comet souths soon after 9 p.m., but will be only some 15 degrees above the horizon at Greenwich. Moving rather quickly to the north-west it will south at about 8 p.m. on February 27, at an altitude at about 25 degrees. Its approximate path amongst the stars of Canis Major is shown on the following diagram. A little sweeping in the position indicated will probably reveal the comet as an elongated nebulous object of about the same apparent brightness as when first discovered on the morning of September 1 last.



Path of Perrine's Comet (1902 B). 1903, February 11, to March 7.

GIACOBINI'S COMET (1902 D).—This comet will be somewhat brighter than in preceding months, though still very inconspicuous. Its favourable position in the heavens will enable it to be well observed during the last half of February. On December 30, as viewed in a 10 inch reflector by the writer at Bristol, the comet appeared about magnitude 11 and 30″ in diameter. The following is an ephemeris:—

Date 1903.			R.A. H.	M.	S.	N. Dec. °	′	Brightness.
January	26	...	6	43	56	12	13	1·77
February	11	...	6	36	36	17	40	1·65
,,	27	...	6	35	44	22	36	1·49
March	15	...	6	42	4	26	42	1·29
,,	31	...	6	55	12	29	59	1·08
April	16	...	7	14	8	32	27	0·90
May	2	...	7	37	50	34	13	0·77

THE GREAT METEORITE OF SINALOA, MEXICO.—An interesting description of a visit to, and analysis of, this object is given by Mr. H. A. Ward, of Rochester, New York, in the *American Geologist* for October last. The great meteorite lies on a farm about seven miles due south of Bacubirito, an old mining town on the Rio Sinaloa, in latitude 26°, longitude 107° W. The meteorite is described as "a long monstrous boulder of black iron, which seemed to be still burrowing to hide itself from the upper world." By the aid of 28 men the object was uncovered and found to be 13 ft. 1 in. long, 6 ft. 2in wide and 5 ft. 4 in. thick. Mr. Ward concluded that this body is the largest and heaviest of its kind known to exist on our globe, and estimates its weight as 50 tons. A piece weighing 11 pounds was detached, and on being polished and etched the Widmanstätten figures were exhibited in a beautiful manner. Prof. J. E. Whitfield, of Philadelphia, gives an analysis as follows:—

Specific Gravity ... ... 7·69

Iron ...	88·944	Sulphur ...	0·005
Nickel ...	6·979	Phosphorus ...	0·154
Cobalt ...	0·211	Silica	trace.

THE LEONIDS OF 1902.—These meteors were keenly awaited at many of the principal observatories in America, but apparently with very little success. Cloudy weather seems to have been very prevalent and to have practically effaced the display at most stations, while at other places where partial observations could be taken there was no evidence of an abundant shower. Very few complete reports appear, however, to have been published, and the explanation seems to be that the sky presented very little considered worthy of record. At Dublin Mr. J. R. Henry noticed no Leonids before midnight on November 14, though a small fireball appeared at 10h. 55m., passing from the direction of Orion to a few degrees above and beyond Castor. On November 17 the same observer counted 8 or 10 shooting stars between the hours of 14 and 15, flashing from the constellation Leo. Some of these objects were probably true Leonids, for though the date appears somewhat late for an active return of this stream, it is certain that Leonids are occasionally distinguished until the end of the third week in November.

Moonlight and clouds, which in a great measure marred the Leonid display, appear to have equally interfered with the Geminids. Indeed, very few meteors could be discerned in the gloomy and frequently overcast skies of December. The year generally will be remembered as one singularly unfavourable for meteoric work, and as retaining this character right up to the end.

THE FACE OF THE SKY FOR FEBRUARY.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the sun rises at 7.43 and sets at 4.45; on the 28th he rises at 6.52 and sets at 5.34.

Small groups of sunspots may be expected.

THE MOON:—

	Phases.	h. m.
Feb. 5	☽ First Quarter	10 13 A.M.
„ 12	○ Full Moon	0 58 A.M.
„ 19	☾ Last Quarter	6 23 A.M.
„ 27	● New Moon	10 20 A.M.

The moon is in perigee at 1 P.M. on the 10th, and in apogee at 1 P.M. on the 22nd.

OCCULTATIONS.—The following are the principal occultations visible at Greenwich:—

Date.	Star Name.	Magnitude.	Disappearance. Mean Time.	Disappearance. Angle from N. Point.	Disappearance. Angle from Vertex.	Reappearance. Mean Time.	Reappearance. Angle from N. Point.	Reappearance. Angle from Vertex.	Moon's Age.
			h. m.	°	°	h. m.	°	°	d. h.
Feb. 6	δ^2 Tauri	4·7	9 45 P.M.	37	5	10 30 P.M.	315	278	9 5
„ 7	115 Tauri	5·4	10 43 P.M.	125	92	11 40 P.M.	240	201	10 6
„ 9	λ Geminorum	3·6	3 56 P.M.	75	115	4 49 P.M.	291	331	11 23
„ 9	68 Geminorum	5·0	11 21 P.M.	126	109	0 25 A.M.	260	231	12 7
„ 11	h Leonis	5·4	9 30 P.M.	74	104	10 27 P.M.	322	343	14 5
„ 14	ν Leonis	4·5	4 47 A.M.	141	113	5 45 A.M.	264	230	16 12

THE PLANETS.—Mercury is in inferior conjunction with the sun on the 2nd; he attains his greatest westerly elongation of 26° 58′ on the 27th, when he rises about an hour in advance of the sun.

Venus is an evening star in Aquarius. At the beginning of the month the planet sets about an hour and a quarter after the sun, whilst at the end of the month she sets two hours after the sun. Near the middle of the month the semi-diameter of the planet is 5″·3, and the illuminated portion of the disc is 0·95.

Mars is in Virgo, rising about 10 P.M., and therefore well placed for observation. He is easily picked up by his brightness and ruddy colour. On the 15th, at 11 P.M., the planet is near the moon, Mars being 3° 22′ to the north. The diameter of the planet is 11″·0, and 0·94 of his disc is illuminated.

Jupiter is unobservable, being in conjunction with the sun on the 19th.

Saturn is a morning star, but for all practical purposes is out of range, as he rises less than an hour before the sun.

Uranus rises in the early morning, about 3 A.M., and this, together with his great southerly declination of 23°, makes him an unsuitable object for observation.

Neptune is in Gemini and well placed for observation, being visible throughout the night. As will be seen by the chart given in last month's issue, the planet is near γ Geminorum.

THE STARS.—The positions of the principal constellations near the middle of the month at 9 P.M. are as follows:—

ZENITH	Auriga.
SOUTH	Orion, Gemini, *Procyon*, *Sirius*, Cetus, Pleiades, Taurus to the S.W., Cancer and Hydra to the S.E.
WEST	Andromeda, Aries, Pisces, with Pegasus and Cygnus to the N.W.
EAST	Leo, Virgo.
NORTH	Ursa Minor, Draco, Cepheus, Ursa Major to the right of Polaris.

Minima of Algol occur at convenient times on 2nd at 7.11 P.M., 20th at 0.5 A.M., 22nd at 8.54 P.M., and 25th at 5.43 P.M.

Chess Column.

By C. D. LOCOCK, B.A.

Communications for this column should be addressed to C. D. LOCOCK, Netherfield, Camberley, and be posted by the 10th of each month.

Solutions of January Problems.

No. 25.

Key-move.—1. Kt to Q4.

If 1. . . . K × Kt,	2. B to B6ch.
1. . . . Kt to B4,	2. Q × Ktch.
1. . . . Kt × P,	2. Q to Q7.
1. . . . P to Q7, etc.,	2. Kt to B3ch.
1. . . . K to Q3,	2. B to B4ch. mate.
1. . . . Anything else,	2. Q to K6ch.

[There are duals, etc., after all other moves of the Knights, except Kt to Q4, also after moves of the RP, and any move of the Bishop which does not guard White's KB3. Not more than three points can be scored for duals, since all of them contain one of the three combinations, (1) QK6ch and KtB3ch; (2) QK6ch and Q × KtPch; and (3) QQ7 and KtB3ch.]

No. 26.

Key-move.—1. Q to Kt3.

If 1. . . . K to B4,	2. R to B5ch.
1. . . . K to K4,	2. Q to Q3.
1. . . . P × P,	2. Q to Kt5.
1. . . . P to B3,	2. Q to Kt4ch.
1. . . P to B4,	2. Q to Q3.
1 . . Kt moves,	2. Q to B3ch.

SOLUTIONS received from "Alpha," 4, 4; W. Nash, 7, 4; G. A. Forde (Capt.), 0, 4; "W. Jay," 7, 4; "Endirby," 7, 4; "Looker-on," 7, 4; A. H. H. (Croydon), 7, 4; W. H. S. M., 7, 4; G. W. Middleton, 7, 4; F. Rickards, 0, 0;

"Tamen," 5, 4; "Quidam," 4, 4; J. W. Dawson, 7, 4; J. W. Dixon, 7, 4; C. Johnston, 7, 4.

"*Tamen.*"—Two out of your four communications were posted too late.

G. W. Middleton.—I much regret the cause of your retirement last year, and am glad to find that you have been able to resume solving.

G. F. Todd.—Your solutions were posted too late to count. It is not in my power to make any exceptions.

G. A. Forde (Capt.).—1. Kt to Q8 is answered by 1. . . . Kt to Q4, the only defence.

F. Rickards.—By Kt to Q6 I must assume you meant Kt to Q8, since you give as a variation 1. . . . K to Q5, without mentioning the capture of the Knight. Other incorrect variations confirm my suspicions.

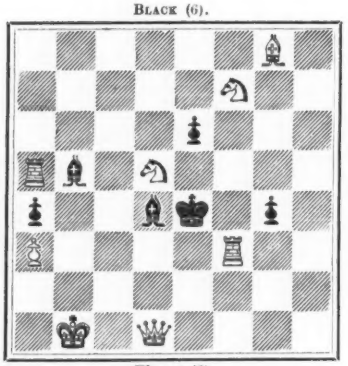
C. Johnston.—No one is more glad than the Chess Editor.

PROBLEMS.

No. 1.

By C. C. W. Sumner.

BLACK (6).



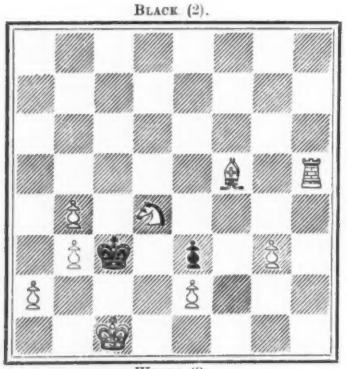
WHITE (8).

White mates in two moves.

No. 2.

By A. Lillie.

BLACK (2).



WHITE (9)

White mates in three moves.

[This problem is remarkable for the fact that its composer, after the lapse of some years, found himself quite unable to solve it.]

I should be greatly obliged if solvers would in future send *key-moves* only, omitting, at any rate, such variations as are free from duals. The solutions of two solvers this month occupy some ten or a dozen pages of MS.—considerably more than all the remainder put together. In their interests, as well as my own, I shall hope for some condensation in future.

PROBLEM TOURNEY.

The following six solvers, none of whom failed in more than two of the tourney problems, are eligible to serve on the preliminary jury, viz :—Messrs. "W. Jay," "Looker-on," W. Nash, J. W. Dawson, C Johnston and G. Woodcock. As the number is very select, I hope that all of these will be willing to give their awards, which should be posted not later than February 22nd. If, however, they could find it convenient to send them with their solutions on or before the 10th, I should be much obliged. With a lighter task before them this month, perhaps they could manage this. Each list sent in must contain six problems arranged in order of merit. Brackets may be used if desired, and more than six problems *may* be included, *provided that all after the fifth are bracketed last.* To a problem placed first on any list I shall give 10 points, to one placed second, 9 points, and so on, so that a problem placed sixth will (apart from brackets) receive 5 points. This appears to me fairer than the system of marking from 6 down to 1; for on that system a problem placed first by a single judge, and omitted by the other five, would score more than a problem placed sixth on five lists. Whereas the latter composition would clearly be of some merit, and the exalted position of the first-mentioned problem might well be due to something accidental or extraneous. The marks awarded to each problem will then be added up, and those six problems which obtain the highest aggregates will alone be considered in my final award. Should, however, the next *one* or *two* come very close, I should reserve the option of taking them into consideration. I have already suggested that any problem which has proved a stumbling-block to any of the "jury" should receive special attention from its victim.

The result of the SOLUTION TOURNEY has not been challenged, and now becomes final.

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